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Chinese Scientists Complete Feasibility Study for Joint Sino-Italian Space Microgravity Experiment

92P60140A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 24 Jan 92 p 1

[Article by Ma Weixian [7456 0787 0341] and Yan Shihua [0917 0013 5478]: "Sino-Italian Scientific Cooperative Project Passes Acceptance Check"]

[Text] The feasibility study for a joint Sino-Italian scientific project to use a European Space Agency small satellite for an outer-space experiment in capillary convection free-surface oscillation passed the acceptance check held a few days ago by a panel of Chinese space experts. In this experiment in microgravity physical flow processes, the scientists will study "gas-bubble and liquid-drop interactions such as migration, diffusion, polymerization, and frontal solidification, as well as capillary convection free-surface oscillation"; they will also explore regularity in space materials processing and other space experiments.

China's Aircraft Engine Technology Said To Be at Advanced International Level

92FE0333 Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 7 Dec 91 p 1

[Article by reporter Zhu Dachiang [2612 1129 1730]]

[Text] Beijing, 6 December (Zhong Xin Press)—Chinese aviation experts today passed certification on the experimental approach and measurement technique for a key component of the aircraft engine, the compressor. They believe that China's technology in this area has reached the advanced international level.

This advanced compressor technology will be used extensively in the development of various aircraft models for the 1990's and will play a major role in stimulating the growth of China's aviation industry. The developers indicate that this technology should be available to foreign aircraft companies in order to promote technical exchange with other countries.

A pre-requisite for the growth of China's aviation industry is to develop a high-performance aircraft engine. The specific area of engine technology where current research efforts are concentrated is the compressor. After devoting 8 years to compressor research and development, engine specialists Jiang Haokang and Chen Maozhang of the Beijing Aeronautics and Aerospace University have made a significant breakthrough in this area; specifically, the four degree-of-freedom rotary positioning mechanism and the high-frequency dynamic pressure measurement technique which they developed are considered to be state-of-the-art technologies.

This high level of achievement in a country with a backward aviation industry surprised many colleagues in the United States, England, the Soviet Union and Germany. The Rolls-Royce Company of England has expressed interest to cooperate with China in a joint effort to construct an advanced experimental facility for compressor development.

Another China-Made Communications Satellite Launched

40100027 Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 2, Feb 92 p 17

[Abstract] Another China-made comsat was launched via an LM-3 on 28 December 1991. A premature shutdown of the third stage's engine after the second ignition caused the satellite to enter a slightly different orbit than planned. Through analysis of telemetry data, the cause of the rocket's malfunction has been pinpointed. It is the leakage of helium gas system controlling the LH_2/LOX engine's valves. The satellite was sent into an elliptical orbit with its apogee at 35088km. Now the various systems on the satellite are operating normally and the satellite is well under ground control. Though it cannot be used as a communications satellite again, multiple science experiments can be carried out on it. The space experts in China commented, "Since we can so quickly pinpoint the cause, we are able to take relative measures to prevent us from suffering another mishap."

Additional Details on LM-4 Launch Vehicle Provided

Main Features

92FE212A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 11, Nov 91 pp 3-7

[Article by Su Shikun [5685 0013 1024], Director of the Ministry of Aerospace Industry's Shanghai Space Bureau: "Main Features of the Long March 4 Launch Vehicle"]

[Text]

Abstract

The Long March-4 (LM-4) is a member of the family of China's Long March launch vehicles. In 1988, the successful launch of the LM-4 extended the mission capability of the Long March family to all earth-orbit satellites including sun-synchronous satellites.

The LM-4 was developed on the basis of the improved first and second stages of the Long March 3 (LM-3) with a newly developed third stage. While the technical achievements of the LM-3 have been inherited, the LM-4 design also incorporates many advanced technologies. For example, a digital network, digital zero-adjustment scheme and two-axis servomechanism have been adopted in the control system; a constant-pressure full-range helium pressurization system and primary-secondary channel design have been incorporated in the third-stage propulsion system; a niobium-alloy nozzle extension is used in the third-stage engine; a surface-tension propellant tank is used in the attitude control engine system; and a single-layer, thin-wall, high-strength aluminum structure with a common base is used for the third-stage propellant tank. All these new technologies have been proven on the LM-4 launch vehicle.

Since it first became operational, the LM-4 has successfully launched two FY-1 meteorological satellites into

orbit; today it has evolved into a multi-function carrier vehicle of the Long March family.

In this paper, the main features of the LM-4 are described, with emphasis on its superior performance, versatility, high reliability and cost effectiveness; the prospects for its future development are also discussed. [End of abstract]

On 7 September 1988, the LM-4 launch vehicle was used for the first time to successfully deliver China's first experimental meteorological satellite, the FY-1, into sun-synchronous orbit. The successful development of the LM-4 launch vehicle extended the mission capability of the family of Long March launch vehicles to all earth-orbit satellites including sun-synchronous satellites.

On 3 September 1990, the second LM-4 was launched according to the scheduled launch-window and delivered China's second FY-1 satellite and two balloon satellites (DQ-1) designed to measure high-altitude atmospheric parameters into sun-synchronous orbit. The required orbit parameters were: semi-major axis 7273.096 km, eccentricity 0.95×10^{-4}, inclination 98.9 deg; the actually attained orbit was: semi-major axis 7274.165 km, eccentricity 0.3×10^{-4}, inclination 98.958 deg. Thus, a very high degree of orbit-injection accuracy was achieved.

The LM-4 launch vehicle has many desirable features including superior performance, versatility, high reliability and cost effectiveness.

Superior Performance

The LM-4 launch vehicle was developed on the basis of the improved first and second stages of the LM-3 launch vehicle with a newly developed third stage. All three stages use the normal-temperature propellants nitrogen tetroxide and uns-dimethylhydrazine (UDMH). Its second stage is identical to the LM-3's second stage, whereas its first stage has a propellant tank which is 4 m longer and contains 40 tons of additional propellant; the total thrust of the four first-stage engines has increased from 2746 kN to 2942 kN.

While the LM-4 has inherited the mature technologies of the LM-3, it has also incorporated many advanced technologies in the newly developed third stage.

For example, it has a digital attitude-control system which uses a digital network, digital zero-adjustment scheme and two-axis servomechanism. The digital network is accurate, versatile, and has good interference-rejection capability. The digital zero-adjustment scheme is twice as accurate as an electromechanical-type zero-adjustment device; the increased accuracy has improved the launch vehicle's lift-off reliability. The two-axis servomechanism has two actuators operated by a single hydraulic supply system in order to reduce the weight-to-power ratio.

The third-stage consists of two independently operated engines which are connected in parallel and have gimballed axes. They are the first upper-stage engines developed by this country which use normal-temperature propellants. Each engine has a thrust of 49 kN and a specific impulse of 2971 m/s; its two gimballed axes are perpendicular to one another and each has a maximum swing angle of 4.5°. It also has dual-start capability when operating in vacuum. The third-stage engine uses a radiation-cooled, niobium-alloy nozzle extension. Its specific impulse and thrust-to-weight ratio are the highest among all normal-temperature-propellant engines developed in this country; they are comparable to the levels of the state-of-the-art engine designs.

The third-stage propulsion system uses a full-range constant-pressure helium pressurization system and primary/secondary channel design. The system is light-weight and highly reliable.

The third-stage propellant tank uses a single-layer, thin-wall, high-strength aluminum structure with a common base. The forward compartment is the fuel tank and the rear compartment is the oxidizer tank; the convex surface of the common base faces the fuel tank.

The attitude-control engine has a surface-tension propellant tank and uses anhydrous hydrazine as propellant. It is used primarily for correcting orbit-injection errors after main engine cut-off and for attitude control during the coast phase. The engine can operate with different types of propellants and can be reused a number of times over a long period.

The superior performance of the LM-4 design is achieved by inheriting existing technical achievements and using well-proven advanced technologies; its performance has been demonstrated by the successful launches and the accurate orbit injection of two meteorological satellites.

Versatility

The LM-4 launch vehicle has sufficient versatility to launch payloads into sun-synchronous orbits and polar orbits as well as geo-synchronous transfer orbits; it can also be launched from any of China's launch centers.

Under present conditions, its launch capability for low-earth-orbit (with perigee height of 200 km and apogee height of 400 km) is 4520 kg, its launch capability for sun-synchronous orbit is 1650 kg and its launch capability for geo-synchronous transfer orbit is 1250 kg. While the LM-4 is the main carrier of China's sun-synchronous and polar-orbit satellites, its launch capability can be further improved by making minor modifications to the vehicle design.

In order to extend its utility, the LM-4 has two satellite fairings with different diameters that can accommodate payloads of different weight and size. It is also equipped with a launcher that can deploy multiple satellites. A key issue of launching multiple satellites is to have reliable satellite/rocket separation techniques. China developed multiple-satellite launch capability in the early 1980s; in September 1981, a group of three research satellites were successfully launched by the Feng Bao-1 launch vehicle. In September 1990, two Da Qi-1 (DQ-1) balloon satellites were launched along with the FY-1 meteorological satellite by the LM-4 launch vehicle; this was accomplished by the efficient utilization of space in the third-stage engine compartment and by installing a special separation mechanism.

Table 1. Launch Capability of the LM-4 Launch Vehicle for Different Satellite Orbits

Inclination (deg)	Perigee Height (km)	Apogee Height (km)	Satellite Weight (kg)
30.5	200	35786	1250
70	200 200	200 500	4590 4520
90	200 750	200 750	4150 2200
99	750 900	750 900	2100 1650

High Reliability

High reliability is a unique feature of all members of the family of Long March launch vehicles. The LM-2 launch vehicle successfully launched 12 recoverable research satellites; the LM-3 successfully launched six geosynchronous communications satellites; and the LM-4 successfully launched two meteorological satellites. Because of their high success rate, the Long March rockets are reliable carrier vehicles for providing commercial launch services for both foreign and domestic customers.

The high reliability of the LM-4 launch vehicle is achieved through a series of design measures to ensure reliability; specifically, the design, testing, production and management during the development process all comply with reliability engineering requirements.

Reliability is a deciding factor in choosing the overall vehicle design as well as subsystem designs. The LM-4 launch vehicle and its subsystems all have clearly defined reliability specifications. For example, normal-temperature propellants are used in the rocket engines for all stages because it is easy to achieve high reliability with the technically mature engine designs. To meet reliability requirements in the subsystems, the following design measures have been incorporated: (1) the use of advanced digital control techniques and two-axis servo-mechanisms in the control subsystem; (2) the use of high specific-impulse, light-weight, upper-stage engines and the development of multiple-restart and reliable ignition technology under weightless conditions for the propulsion subsystem; (3) the use of pulse-coded amplitude-modulation techniques in the telemetry subsystem; and (4) the development of a compact onboard CW responder for the tracking and measurement subsystem. These reliability measures in subsystem design and the incorporation of many technological breakthroughs have resulted in high LM-4 system reliability.

Of course, reliability assurance also depends on the development process, which must follow the general guidelines given in the document "Reliability Assurance Guidelines for LM-4"; these guidelines include reliability enhancement tests, reliability design reviews and evaluations, and strict quality control. For example, even though the technically mature ejection-tube separation mechanism is used for the satellite fairings of the LM-4, repeated separation tests are still conducted on the ground to ensure its reliability.

During the development of the LM-4, a policy of prevention-oriented quality-control is adopted. Guidelines for quality assurance have been established jointly by the design engineers and the quality-control departments for research and development, production and testing. At each level and each stage of development, a quality assessment procedure has been established for design, processing and production; a similar review and evaluation process has been established for reliability design. Strict quality-control procedures and reliability measures are also used in ground testing, in the application of new technologies, and in the design of new products. If difficulty is encountered in product development, every effort is made to determine the cause of the problem. Prior to launch, the rocket is subject to a set of rigid quality review procedures. These quality assurance measures are the basis for the high quality and high reliability achieved by the LM-4 launch vehicle.

Cost Effectiveness

One of the outstanding features of the LM-4 launch vehicle is its cost effectiveness. Because of its low development cost and low launch cost, it is a strong competitor in the market for commercial satellite launch services. An important approach used to reduce development costs is target cost management, which is based on the application of the following principles in the overall design: (1) apply only mature technologies which have been proven in flight tests; (2) never compromise overall performance and system reliability for the purpose of pursuing advanced component technology; (3) essential new technologies should be adopted only after their reliability has been verified by thorough ground tests; (4) optimize tests of the vehicle by using simple and easily performed test procedures; (5) take advantage of technical achievements developed in different parts of the country and avoid duplication of efforts. Once the overall design is finalized, a carefully controlled budget is established for each phase of design, testing and production; cost control measures are implemented to eliminate unnecessary expenses and to minimize waste.

The use of normal-temperature propellant for the LM-4 launch vehicle reduces the launch cost because it simplifies the ground equipment and reduces the required launch-site services. The LM-4 can be accommodated by the launch facilities at China's Taiyuan, Xichang and Jiuchuan satellite launch centers.

Future Prospects

As the LM-4 is a basic carrier for China's sun-synchronous and polar-orbit satellites, the demand for its launch service is expected to grow in the future. For example, the LM-4 has been designated as the launch vehicle for the earth-resources satellite ZY-1 jointly developed by China and Brazil.

The LM-4 launch vehicle can accommodate a wide range of payloads by modifying its existing configuration. As an example, the first two stages of the LM-4 can be used to build a two-stage rocket capable of delivering a 3100-kg payload into a 200-km, 70°-inclination low-earth orbit.

By strapping solid boosters onto the first stage of the LM-4, it is possible to build a new strap-on rocket. For example, by strapping six 559-kN solid boosters onto the LM-4, it can launch a 5700-kg payload into a polar orbit with a perigee of 200 km and an apogee of 400 km. By strapping on eight such boosters, the payload capability can be increased to 6,300 kg. The large payload capability makes it particularly suitable for launching multiple satellites.

The LM-4 is a member of the family of China's Long March launch vehicles; its main features represent the basic features of the Long March family. These features are also the primary reason that China's launch vehicles are highly competitive on the international market for satellite launch services.

Reliability

92FE0212B Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 11, Nov 91 pp 7-9

[Article by Bao Xiandong [7637 6343 2767] of the Shanghai Institute of Electromechanical Equipment: "Reliability of the Long March 4 Launch Vehicle"]

[Text]

Abstract

This paper describes the design principles and technical approaches used to improve the reliability of the Long March-4 (LM-4) design; in particular, it introduces the effective measures used in its development for ensuring and enhancing product reliability. The paper also presents the results of reliability assessment of the first batch of products of the LM-4.

Reliability is the key factor that affects the survival and development of launch vehicles; during the development process of the LM-4, at each step from design verification to flight test, a fundamental principle has always been to enhance and to ensure the reliability of the final product.

The reliability-related tasks during the development include: allocation of design specifications, construction of reliability models, reliability prediction, failure mode effect and catastrophe analysis (FMECA) and failure tree analysis (FTA), reliability enhancement tests, and design review and evaluation. These efforts have raised the LM-4's reliability to a new horizon and have played a key role in the success of the first two flight tests.

I. Reliability Design

1. Design Specification

At the end of the prototype development phase, the structural reliability of the LM-4 should be no less than 0.8 with a degree of confidence of 0.7.

2. Design Principle

The following two basic principles are adopted in the LM-4's design:

(1) Inherit mature technologies

The LM-4 has inherited the research accomplishments and mature designs that have been well proven on previously developed vehicles. For example, the first two stages of the LM-4 are developed on the basis of an improved Feng Bao-1 (FB-1) two-stage rocket; they share the same structural design and processing technology. The second-stage engine is the YF-24F engine whose reliability has been fully demonstrated in repeated flight tests. The control system's platform, rate gyro, and servomechanisms have all inherited technologies originally developed on the LM-3. Even the newly designed components such as the detection power amplifier, the secondary power supply, the third-stage servomechanism and the first-stage engine all have incorporated valuable experience obtained from previous development programs.

(2) Incorporate new technologies; emphasize design verification and experimental research.

The LM-4 design has also incorporated a number of new technologies; they include: the digital attitude control system; the thin-wall, single-layer, common-base third-stage propellant tank; the dual-starting, normal-temperature-propellant third-stage engine; the two-axis gimballed servomechanism; the surface-tension anhydrous propellant tank; the 251 continuous-wave (CW) Doppler positioning responder; the computer-automated measurement and control (CAMAC) system; and the test launch and control system. To ensure a high degree of reliability in the LM-4 design, all new systems and components have been subject to strict design reviews and extensive ground tests.

3. Design Approach

For LM-4 launch vehicle, engineers have adopted the following design approaches to enhance reliability:

(1) Redundancy

Although no hardware redundancy is used above the unit level, it is used extensively at the parts level for key functions and in critical circuits. In the overall design, the reliability of first-stage engine cut-off is ensured by providing fuel-depletion cut-off and time-controlled cut-off as backups to the velocity-controlled engine cut-off; in the second stage and third stage, a small-overload cut-off and time-controlled cut-off are used as backups to the velocity-controlled engine cut-off; and a time-controlled engine cut-off is also provided as backup for the terminal velocity-correction phase. In order to prevent unintentional engine cut-off due to erroneous commands, a cut-off window is implemented in the flight programs of different stages.

Between the turbine and the pump of the third-stage engine, two-tier mechanical seals supplemented with oil-film separation measures are used. In order to improve the reliability of engine ignition at high altitude, a dual pressure-controlled and time-controlled ignition procedure is used to ensure that the oxidizer enters the thrust chamber prior to ignition.

In the full-range, constant-temperature helium pressurization system of the third stage, a gas-supply design with parallel primary/secondary pressurization channels is

used. When the primary pressurization channel fails to function due to pressure drop in the gas bottle which causes the pressure reducer to malfunction, normal pressurization of the propellant tank is still maintained by the secondary pressurization system.

In the control system, redundant designs are used for important signal paths and connectors; for example, the control circuit of the third-stage two-axis servomechanism and the feedback circuit have parallel input and output; the power distributor circuit has dual-relay and dual-contact designs; the main power supply uses a multiple-contact interlock design; also, bridge connectors are used between the dual-contact circuits of the electric cables to improve reliability.

(2) Specification compliance

The components selected for the electronic system of the LM-4 are generally used under conditions which are within the environmental and load specifications given in the "Guidelines for LM-4 Reliability Assurance." Components which are used under conditions which exceed the specifications are subject to careful design review and evaluation.

(3) Other design approaches

Other design approaches including thermal design, anti-interference design and anti-mechanical environment design are used in designing the onboard computer, the platform accelerometer and other electronic equipment.

II. Reliability Enhancement Measures

Through various ground tests, the defects and weak links of the design and the production process have been exposed. By finding the cause of the problem and taking appropriate measures, the product reliability can be enhanced until it reaches the expected level.

1. Reliability Enhancement Tests

Based on the analysis results of FMECA, a total of 14 different reliability enhancement tests were conducted for more than 20 units and components on board the vehicle. The onboard electronic equipment units have accumulated over 1000 hours of life tests under normal temperature and load conditions; the electromechanical equipment units have accumulated 500 times the number of on-off tests or operational cycles required for flight tests. After the above tests, the products are subject to further high- and low-temperature tests and vibration tests in order to ensure full exposure to the required environmental conditions.

2. Typical Examples

Enhancement of product reliability using innovative measures is illustrated by the following examples.

(1) The problem of interface reliability

During the process of final assembly and testing, a short circuit in the diode of the input isolation circuit connecting the time-command converter of the telemetry system and the control system caused chaos in the flight program. In order to prevent the recurrence of similar malfunctions, all of the 120 or more interface connectors between the telemetry system and the control system were subject to careful reliability design review. Also, a series of measures were taken to enhance interface reliability; these included the use of reliable isolation components such as photoelectric couplers, relays and transformers; installation of large series resistors at the input; and performing analysis to detect hidden short circuits. With the improved interface circuit design, failures in the electronic components of the telemetry system will not cause indirect failure in the control system.

(2) The problem of fire leaks in the third-stage engine

The second batch of YF-40 engines had experienced numerous fire leaks during tests. To solve this problem, the following design modifications have been made to the engine seal configuration: the original metallic "O" rings were replaced by soft graphite seals; at the entrance of the secondary system, the rotary joint was replaced by a welded structure, and the aluminum gasket seal was replaced by a flare seal; in the hot gas system, the metallic "O" ring seals and the copper-gasket seals were replaced by graphite seals; and for the remaining metal gasket seals, improvements were made by using deeper positioning grooves and applying adhesive coatings. Ground tests of the improved YF-40 engines showed that fire leaks were eliminated and the reliability of the engine structure was verified.

(3) The problem of valve contamination

During the final test of the second batch of rockets, there were incidents of low-pressure gas leaks through the valves due to contamination of the seal surface. Subsequent inspection showed that the contamination was caused by dirty test equipment used in the laboratory. In an effort to completely correct this problem, it was decided to disassemble and clean all the spare parts and the valves in storage, replace all the gaskets, and then reassemble; also, all the links that could potentially cause contamination were disassembled and washed, and reinstalled with filters. As a result of the disassembly and inspection process, 46 contaminated valves were discovered, and the reliability of the pressurization system was restored.

3. Effectiveness of Reliability Enhancement

As a result of the various improvements made during the development of the LM-4 launch vehicle, its reliability increased accordingly. This was reflected by the decreasing number of failures at each stage of the development process, as indicated in Table 1.

Table 1. Number of Failures at Each Stage of LM-4 Development

Item	Combined Test Rockets	First Flight Test	Second Flight Test
Total number of failures	83	41	15
Number of onboard system failures	26	15	13
Number of catastrophic failures	2	0	0
Number of serious failures	27	9	1
Number of component failures and outer-member failures	17	9	4

III. Reliability Assessment

Reliability assessment of the first batch of LM-4 launch vehicles was performed after the second flight test. Based on the results of ground test and flight test data, the lower confidence limit for reliability of the LM-4 was estimated to be 0.9000 (with a degree of confidence of 0.7).

IV. Concluding Remarks

Improving product reliability is the main design goal of the LM-4 launch vehicle. Systematic efforts in reliability design, analysis and management have been carried out in the development process to meet reliability engineering requirements. In the design phase, various design approaches were used to enhance product reliability; in the development phase, every weak link of the system was carefully treated, and reliability enhancement tests were conducted. As a result, the LM-4 has attained a reliability of 0.9 (with degree of confidence 0.7), which is comparable to the reliability of similar launch vehicles built by developed countries of the world. Therefore, China is in a good position to compete in the international satellite-launch market.

Technical Details on C801 Missile Released

Propulsion System

92FE0192A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 11, Nov 91 pp 41-43

[Article by Qiu Shanchang [6726 0810 2490] and Zhou Zhonglin [0719 0022 7227]: "China's C801 Missile Propulsion System"]

[Text]

Abstract

The performance of the C801 missile is greatly improved by using solid rocket motors for both its booster engine and sustainer engine. This article describes the structural components, design features and processing methods of the sustainer engine as well as some of the technical problems encountered during its development. In addition, it also describes the charge design of the C801 booster and its ignition safety mechanism.

Introduction

A major breakthrough in the propulsion system of China's C801 naval defensive missile is that it uses solid motors for both its booster engine and sustainer engine. As a result, the combat performance of the C801 is greatly improved in comparison with similar missiles of the previous generation. This new design not only simplifies the ground equipment and improves its mobility, it also simplifies the missile structure, improves the reliability of the propulsion system, and significantly reduces the requirements for ground maintenance and pre-launch preparation. It can be said with certainty that a propulsion system using all-solid-propellant motors has become a key feature of the naval defensive missiles of this generation.

Development of this propulsion system began in 1978, and it was certified for mass production in 1985. Experience with the development tests and production of this system has shown that its performance is steady and reliable, and fully meets the overall design requirements of the missile. Also, the manufacturing technique of the system is quite mature, the supply of raw materials is plentiful, and the acceptance rate of the product is very high.

I. The Sustainer Engine

The solid rocket motor has many desirable features; however, the sustainer engine of an anti-ship cruise missile must be able to operate at low thrust levels (generally several kN) over long durations (generally 100-200 seconds). These requirements present two challenging problems for the system designer: accurate control of the combustion surface and effective heat protection measures.

Under the conditions that the performance of the propellant and the throat area of the jet nozzle remain unchanged, the thrust of the rocket engine is determined by the combustion area of the grain. To operate at low thrust levels over long durations requires a large grain volume but small combustion area; in other words, a large portion of the surface area must be shielded with only a small area participating in the combustion process. The shield must be effective and reliable because even a small piece of shield detached from the surface will result in a significant rise in the thrust level. For an engine with internal-cavity combustion, normal engine operation will not be affected as long as the detached part of the surface area is not directly connected to the combustion cavity; but for a small engine with end-surface combustion, the combustion cavity sweeps across nearly the entire shielded surface, hence detachment of any part of the surface cannot be tolerated. Therefore, the first challenging design problem is to accurately and reliably control the combustion surface.

Unlike liquid-propellant engines whose structural components are protected from overheating by cooling, the solid rocket motor can only be protected by insulation techniques. Because a low-thrust, long-operating engine is small in size and subject to heating load over long durations, it must be covered with sufficient amount of insulation material which may be a significant fraction of its

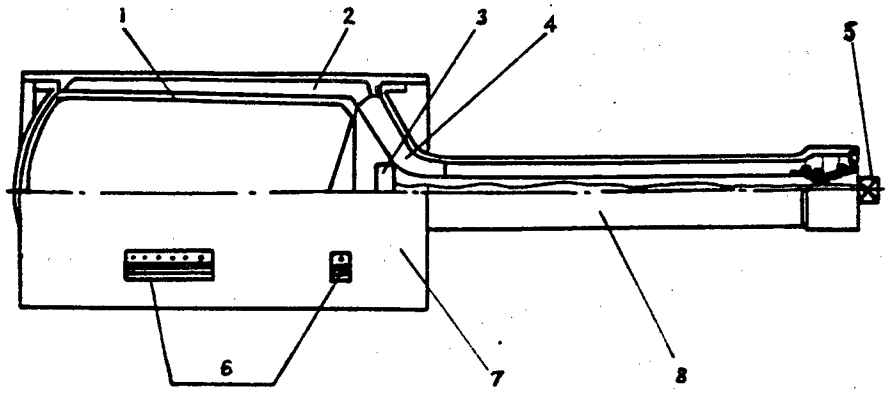

Figure 2. Structural Diagram of the C801 Sustainer Engine

Key: 1. Wrapping of grain column; 2. Flexible insulation layer; 3. Ignition unit; 4. Insulation material for the long tail pipe; 5. Filter; 6. Missile-wing joints; 7. Charged combustion chamber; 8. Long tail pipe

total weight. The appearance of ablation materials provides a potential solution to this problem; however, many design issues must still be addressed: e.g., proper selection of engine parameters; clever structural design to take full advantage of the unique property of each material; and solving the problem of excessive thermal stress and possible failure of sealing materials caused by variations in the physical properties of different materials and non-uniformities in temperature distribution. This is the second challenging design problem.

The sustainer engine of the C801 missile has three major components: the charged combustion chamber, the long tail pipe and the ignition unit. The main charge is a solid grain column whose cone-shaped rear section is the combustion surface, and whose side and front sections are covered with light-weight, elastic wrapping materials. The propellant is a low-aluminum-content poly-sulphur composite charge; the choice of its composition is based not only on the requirements of total impulse and thrust of the engine, but also on such considerations as combustion stability, heat-protection reliability, and ease of fabrication. Such a design approach ensures good overall engine performance. The cylindrical section of the combustion chamber housing is manufactured using the spinning technique; it is made of conventional alloy steel and is arc-welded to the head section. The inner wall of the housing is lined with a thick layer of insulation material made of rubber, resin and asbestos; the temperature rise at the end of engine operation is limited to 100°C. The grain column is rigidly bonded to the forward sealed head section to avoid relative motion and friction between the grain column and the housing during shipping at low temperatures. Located in front of the long tail pipe is the rear sealed head section of the combustion chamber; it is lined with molded bakelite reinforced with high silicon-oxide fibers. The mid section is a constant-diameter gas pipe where high gas velocity (150 m/s) and high heating load occur; because the thickness of the ablation material is limited by structural constraints, high silicon-oxide plastic material is used for this section. This material has low and stable ablation rate, and provides adequate reliability in spite of its limited thickness. Located behind the long tail pipe is the exhaust nozzle where maximum heating load occurs. Since the throat diameter is less than 20 mm, only an extremely small amount of ablation can be tolerated; in order to meet this requirement, the throat section is made of tungsten, which is a metal with a very high melting point. The shape of the nozzle and the structure of the surrounding parts are designed to preserve structural integrity and to ensure reliable and tight seals under adverse operating conditions. The sustainer engine of the C801 missile and its structural diagram are shown in Figure 1 [photo not reproduced] and Figure 2, respectively.

II. Booster

The booster of the C801 missile is connected serially to the second stage (see Figure 3 [photo not reproduced]); this configuration makes it possible to reduce the lateral dimensions of the missile and to increase the number of missiles carried by ships. However, the length of the missile must also be controlled, which requires imposing strict limitations on the booster's axial dimensions. To accomplish this, the specific impulse and density of the propellant as well as the charge packing density should be as high as possible. We have chosen the high-combustion-speed, high-aluminum-content, butyl-hydroxy composite propellant and the shell-adhesion-type thick-charge design. While this design satisfies the weight and size requirements, the propellant contains small oxidizing-agent particles and has poor mechanical properties. On the other hand, the internal stress of the grain column increases rapidly with increasing thickness, which may cause the grain column to develop cracks and to detach from the housing. For this reason, stress-relief devices are installed at both ends of the grain column. Stress calculations and test results under severe environmental conditions show that the device is quite effective in improving the reliability of booster operation.

III. Ignition Safety Mechanism

Because of the complex electromagnetic conditions encountered in modern warfare, old-fashioned electric detonators may be subject to accidental detonation. To guard against such accidents in the design of modern naval defensive missiles, the detonators and supply circuits of the sustainer engine are all located inside the missile to protect them from external electromagnetic fields. Another safety measure is to use a low-pass filter whose effectiveness as a safeguard device has been demonstrated by field tests under electromagnetic environment. The ignition system of the booster has long supply circuits which are exposed to the electromagnetic environment outside the launch module; also, any operational error during training or test will have grave consequences. Therefore, we have installed a highly reliable mechanical safety mechanism (see Figure 4 [photo not reproduced]) which is driven by a d.c. motor controlled by the launch and control console. The action signal of the safety device is fed back to the launch and control console where it is displayed by the indicator light and also sent to the automatic launch and control program to ensure safe operation of the missile.

The final design of the C801 propulsion system has been widely praised for its reliability, safety and ease of operation. However, because it is only the first-generation product of this type developed in this country, some defects are to be expected. As the system matures with increasing time in service, its structural configuration and performance will undoubtedly improve.

Autopilot

92FE0192B Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 11, Nov 91 pp 44-47

[Article by Zhan Yougen [6124 2589 2704]: "C801 Missile Autopilot"]

[Text]

Abstract

The main control system on board the C801 missile is the autopilot. In this paper, the components, the functions and the key technical specifications of the autopilot are described; also, the design features and the test procedures are briefly discussed.

Introduction

The C801 is a high-subsonic, low-flying, multi-function anti-ship missile. It can be carried by speed boats, escort ships, destroyers and submarines as well as airplanes. Its main tactical function is to attack medium-size surface ships such as destroyers and small surface ships such as speed boats. The main control system on board the C801 missile consists of the autopilot and the terminal guidance radar.

I. Components and Functions of the Autopilot

The autopilot of the C801 missile consists of six components with 12 different parts: the gyro assembly, the dedicated analog computer, the radio altimeter, the magnetic-powder-clutch electric rudder, the servo-mechanism electric rudder and the integrated power supply (see Figure 1 [photo not reproduced]).

The main functions of the autopilot are:

1. To achieve stability of the missile attitude relative to the center of gravity;

2. To control the missile flight according to a pre-programmed trajectory until it reaches level flight at a pre-assigned altitude;

3. To receive commands from the ship or airplane and load the initial pitch, tilt and sector angles in preparation for moving-platform launch or sector-angle mobile launch;

4. To receive control signals and commands from the navigation radar during the terminal phase and to perform double-descent maneuvers, tracking and final dive maneuver toward the target.

II. Key Technical Specifications of the Autopilot

The key technical specifications of the C801 autopilot are presented in Table 1.

Table 1. Technical Specifications of the C801 Autopilot

Item	Specification
Drift of the outer gimbals of the gyro assembly	No greater than 2°/5 min
Radio altimeter	1) Range linear output: 0-200 m
	2) Altitude measurement accuracy: 0.6 +/- 4%H (m) for H ≥ 10 m; +/- 1 m for H ≤ 10 m
	3) Time constant: no greater than 0.1 sec
Magnetic-powder-clutch electric rudder	1) Maximum torque: 78.4 N-m or greater
	2) Maximum turn angle: 20° or larger
	3) Maximum idle speed: 60°/s or greater
Servomechanism electric rudder	1) Maximum torque: 14.7 N-m or greater
	2) Maximum turn angle: 25° or larger

Table 1. Technical Specifications of the C801 Autopilot (Continued)

Item	Specification
	3) Maximum idle speed: 60°/s or greater
Altitude of level flight	1) 20 m or 30 m (also 10 m)
	2) Altitude after double-descent maneuver: 5 m or 7 m
Angular range of moving-platform launch	1) Initial pitch angle: +/- 25° (launch range 10° - 20°)
	2) Initial tilt angle: +/- 25° (launch range -6° - +6°)
Sector-angle launch	Sector launch angle: +/- 30°
Sensitivity of autopilot	Azimuth channel: no greater than 0.4°
	Tilt channel: no greater than 1°
	Pitch channel: no greater than 0.4°
Electric zero setting	No greater than 0.5°
Preparation time	No greater than 1 min
Total weight	No greater than 52 kg

III. Main Features of the Autopilot

1. Compact Size

The autopilot is small in size and light-weight. It consists of six modules containing 12 different parts; most parts are electronic components with only a smaller number of electro-mechanical components. The structure of the autopilot is sufficiently compact to fit inside the autopilot compartment, which is 700 mm long and 360 mm in diameter.

2. Special-Purpose Analog Computer

The special-purpose analog computer is the core control unit of the autopilot; it is made of electronic hardware such as integrated circuits and miniature relays, and its software includes the altitude program and the pitch program. The main function of the analog computer is to perform integration, differentiation, addition, subtraction and control-state operations on the input attitude angles, altitudes, initial angles and navigation control signals; it also generates signals of angular difference, altitude difference, angular integral, and angular derivative, and forms a composite signal with sufficient power to drive the rudder mechanism. The rudder mechanism in turn operates the rudder surfaces which control the missile flight along a designated trajectory and the dive maneuver toward the target.

The programmed altitude profile is shown in Figure 2 and the pitch profile is shown in Figure 3.

The conditions for generating "G" commands in the analog computer are: 1) the pitch angle (v) must be less than 0°; 2) the flight altitude must be less than 100 m; and 3) the autopilot must have received the booster drop-off command. After the "G" command is issued, the low-level flight of the C801 missile is controlled by the altitude-difference signal.

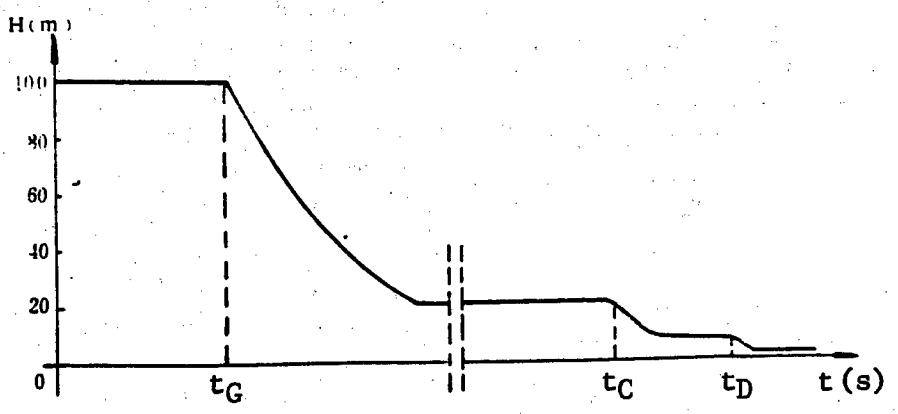

Figure 2. Programmed Altitude Profile of the C801 Missile

t_G—time when the "G" command is issued; t_C—time when the combat command is issued; t_D—time when the dive command is issued

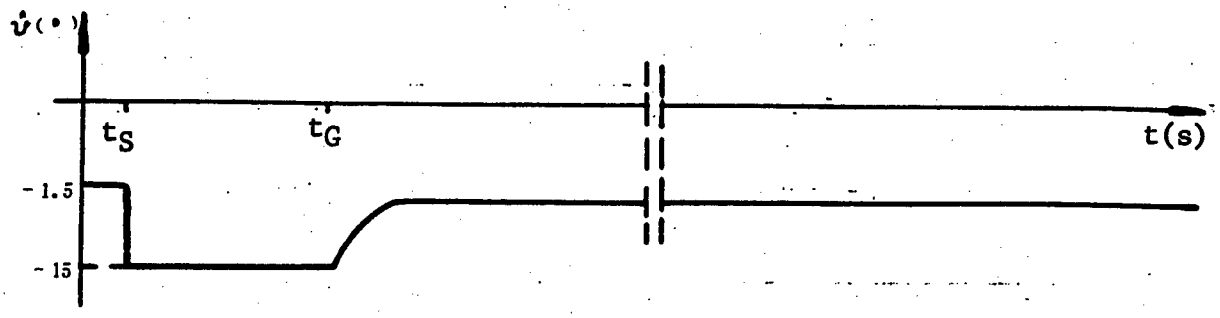

Figure 3. Programmed Pitch Profile of the C801 Missile

t_S—time when the booster drop-off command is issued; t_G—time when the "G" command is issued

3. Electric Differential Control

The rudder surfaces of the C801 missile are arranged in an "XX" configuration. Control of the missile's azimuth channel, tilt channel and pitch channel is accomplished by systematically turning the four rudder surfaces. However, the "XX" rudders cannot be controlled by mechanical transmission systems because they cannot fit in the rear compartment of the second stage, which also contains the large engine nozzle. For this reason, the C801 missile uses four rudder mechanisms which independently operate four insertion-type rudder surfaces, each with its own locking device. Driven by the composite signal from a single channel, the four rudder mechanisms can turn each rudder surface in different directions according to aerodynamic requirements. The advantage of differential control is that the operations of the four rudder mechanisms are synchronized and highly accurate because they are controlled by a single composite signal.

4. Moving-Platform Launch

The carrying vehicle of the C801 missile is either a ship or an airplane which is always in motion on the ocean surface or in the air; hence the missile is generally launched from a moving platform. In order to ensure that proper missile attitude is maintained during flight, the longitudinal and lateral roll angles of the carrying vehicle and the gyro errors caused by sector-angle launch should be loaded into the analog computer of the autopilot. These parameters are stored in the computer memory so they can be used to correct attitude deviations during flight and to provide the initial conditions for activating the terminal guidance radar and for target acquisition.

5. Sector-Angle Mobile Launch

Instead of launching the C801 missile directly at the target, it is possible to use the sector-angle mobile launch technique, where the range of sector angle can be +/- 30°. Based on the acquired target information, real-time calculations are performed by the launch command unit to generate a voltage signal proportional to the sector angle, and send the signal to the analog computer of the autopilot. After the missile is launched and the booster dropped, the sector-angle signal is used to control the turn maneuver according to an exponential law; the duration of the turn is approximately 15 sec. At the end of the turn, the turn angle is equal to the pre-set sector angle in the launch command unit. An illustration of the turn maneuver is shown in Figure 4.

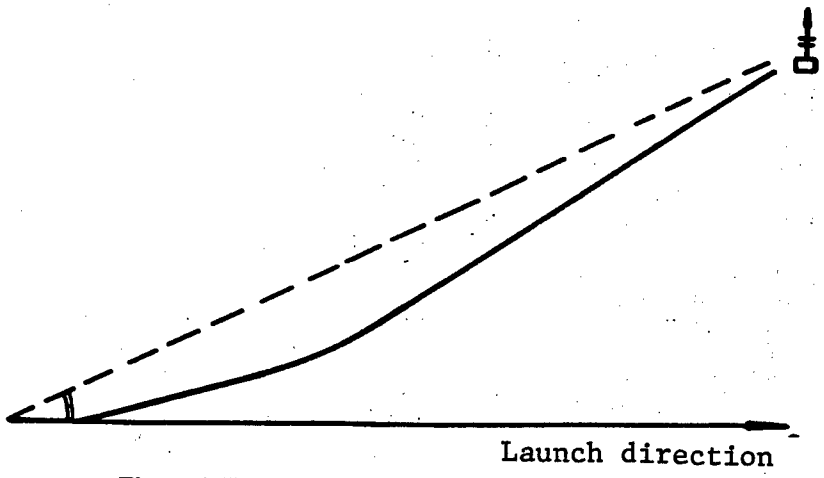

Figure 4. Illustration of the C801 Sector-Angle Mobile Launch

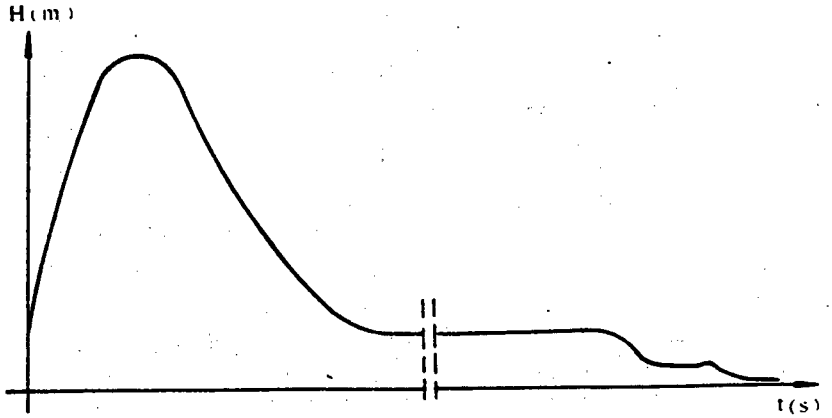

Figure 5. Longitudinal Trajectory of the C801 Missile in Low-Level Flight

6. Control of Low-Level Flight

The C801 missile has good stability and controllability, which are prerequisites for low-level flight. To achieve low-level flight, we have developed a solid-state radio altimeter with good low-altitude performance; this altimeter is the basic altitude-measuring unit of the autopilot. The measured altitude of the missile (i.e., distance from sea level) is converted into a voltage signal which is sent to the analog computer of the autopilot. The signal is compared with the programmed altitude profile to generate signals of altitude difference, altitude derivative and altitude integral, which are used to control low-level flight. Test results have shown that the measured level-flight altitude is 19 m, compared with the pre-set value of 20 m, and the measured double-descent altitude of 5 m or 7 m is consistent with theoretical predictions. The longitudinal trajectory of the C801 missile in low-level flight is shown in Figure 5.

7. Single Plane Guidance

The tactical cruise missiles used by military units are all equipped with two-plane terminal guidance radars which use both bearing and altitude control signals to control the missiles. However, the terminal guidance unit of the C801 missile is a single-plane radar which only transmits bearing control signals to the autopilot. To control the altitude profile, the radar simply transmits the altitude combat commands and dive commands to the autopilot. The radio altimeter measures the missile altitude in real time and generates the altitude signals which are compared against signals of the programmed altitude profile to produce altitude-difference signals. The difference signals are synthesized and amplified to drive the rudder mechanism, which in turn operates the rudder surfaces to control the missile's double-descent and dive maneuvers. During the terminal guidance phase, the missile descends slowly, and remains concealed as it approaches the target, thereby enhancing its survivability and increasing its effectiveness of target hit.

IV. Test Procedure of the Autopilot

After assembly of the autopilot is completed, a special set of test equipment is used to perform inspection and adjustment of the unit. Once it is installed on the C801 missile, both unit tests and integrated tests are performed using automated test equipment. After an approximately 20-min test, test results are printed to indicate which units meet the requirements (denoted by a check mark) and which units fail to meet specifications (denoted by an "X"). If trouble develops in the autopilot, a set of trouble-shooting procedures is provided for the user to isolate the problem; so long as the user has a good understanding of the basic principles of the autopilot, it is very easy to trouble-shoot and to maintain the unit.

Xian Satellite Control Center, China Satellite TT&C Network Described

92FE0167A Beijing ZHONGGUO HANGTIAN [AEROSPACE CHINA] in Chinese No 10, Oct 91 pp 44-47

[Article by Zhang Yinlong [1728 3009 7893] of the Xian Satellite Control Center: "Xian Satellite Control Center, China Satellite TT&C Network"]

[Text] **Abstract**

The China Satellite TT&C Network consists of the Xian Satellite Control Center (XSCC) and a number of TT&C stations under its command, which include the Changchun station, the Minxi station, the Xiamen station, the Weinan station, the Nanning station and the Kashi station, as well as three mobile stations and ocean-going instrumentation ships. The XSCC is equipped with a multi-function data processing system, a command and monitoring system and a communications system. The China Satellite TT&C Network is capable of providing state-of-the-art TT&C services for recoverable satellites and geosynchronous satellites.

I. Brief Description of the China Satellite TT&C Network

The China Satellite TT&C Network consists of the Xian Satellite Control Center (XSCC) and a number of TT&C stations, as well as ocean-going instrumentation ships. The XSCC is the communications hub, the command and control nerve center and the data processing center of the China Satellite TT&C Network. The name XSCC is generally synonymous with the China Satellite TT&C Network because it serves as its administration headquarter.

1. Components of the China Satellite TT&C Network

The China Satellite TT&C Network has the capability to provide TT&C services for both low-earth-orbit (LEO) satellites and geosynchronous satellites. It includes the following seven special systems:

(1) Tracking and Measurement System

The tracking and measurement function of the satellite is performed using radar tracking and measurement equipment; specifically, motion parameters of the satellite including range (R), azimuth (A), elevation (E) and range rate (R[dot]) are measured to determine the satellite orbit elements.

(2) Telemetry System

Radio telemetry equipment is used to receive and demodulate the telemetry signals from the satellite to obtain information on the satellite's engineering parameters and detection parameters.

(3) Remote Control System

Radio remote control equipment is used to transmit control commands to the satellite for controlling the motion and operation of the satellite.

(4) Data Processing System

The data processing system consists of computer hardware and software. Three different categories of computers are used in the system: computers at the XSCC, computers at the TT&C stations and the microcomputers associated with the TT&C equipment. The computers at the XSCC are mainframe computers designed to perform complicated real-time and off-line data processing functions. The computers at the TT&C stations are minicomputers or microcomputers used primarily for data collection and data exchange; they also have some data processing capability. The microcomputers associated with the TT&C equipment are TT&C terminals used primarily for data recording and monitoring.

(5) Communications System

The communications system consists of the line terminals, the data transmission terminals, the switching equipment and the communications links. The communications links include wire links, wireless links and satellite communications links. The mode of communications may be voice, telegraph, facsimile, data transmission and television video transmission.

(6) Time and Frequency System

The time and frequency system consists of the timing equipment, the signal generators and the frequency standard. The time and frequency systems of the XSCC and the TT&C stations are set by the timing signals broadcast by the Shaanxi Observatory to ensure time synchronization of the entire TT&C network.

(7) The command and monitoring system consists of the voice scheduling equipment, the monitoring display unit, the keyboard and the instruction generation equipment. It is used to collect and display the information about the operating conditions of the TT&C network, the TT&C equipment and the spacecraft for the commanding officers and analysts. It is also used to transmit command and control instructions.

2. Primary TT&C Stations of the China Satellite TT&C Network

The TT&C stations of the China Satellite TT&C network can be divided into three categories:

(1) Fixed TT&C Stations for LEO Satellites

The Changchun station, the Nanning station and the Kashi station are three fixed TT&C stations designed for LEO satellites. The main TT&C equipment at these stations includes the VHF/UHF unified TT&C unit, the dual-frequency Doppler tachometric unit, the telemetry and demodulation equipment, the remote control unit and the monopulse radar. The VHF/UHF unified TT&C unit uses channel synthesis technique to perform the functions of R, A, E and R[dot] measurement, telemetry and remote control; the range-rate measurement error is less than 0.1 m/s. The range measurement error of the monopulse radar is less than 10 m, the angle error is less than 0.2 mil, and the range-rate error is less than 0.2 m/s.

The Nanning station is expected to acquire S-band TT&C equipment in the near future, its uplink frequency will be 2025-2120 MHz and its downlink frequency will be 2200-2300 MHz. The configuration and technical specifications of this new equipment are identical to those used in other countries.

(2) Fixed TT&C Stations for LEO/Geosynchronous Satellites

The Weinan station, the Minxi station and the Xiamen station are three fixed TT&C stations deigned for LEO and geosynchronous satellites. The main TT&C equipment at the Weinan station and the Minxi station includes the dual-frequency Doppler tachometric unit, the telemetry and demodulation unit, the remote control unit, the C-band unified TT&C unit and the C-band guidance unit. The C-band unified TT&C unit is capable of performing the functions of R, A, E and R[dot] measurement, telemetry (coded telemetry and analog telemetry) and remote control (command control and synchronous control). The aperture size of the antennas used at these stations is 10 m; the mode of carrier modulation is PM/FM [phase modulation/frequency modulation] for the uplink and PM for the downlink; the range measurement is accomplished

using a mixed pseudo-code/side-tone system. The range measurement error is less than 10 m, the angle measurement error is less than 0.15 mil, and the range-rate error is less than 0.03 m/s (uplink phase modulation).

The Weinan and Xiamen stations are expected to acquire international standard C-band unified TT&C systems in 1991. This system uses an uplink frequency of 5925-6425 MHz and a downlink frequency of 3700-4200 MHz; its antenna has an aperture size of 15 m and its range measurement is accomplished using a digital side-tone system. The technical specifications of this system are basically identical to those of the C-band TT&C systems used in this country.

(3) Mobile TT&C Stations

The three mobile stations include the No. 1 and No. 2 mobile stations and the recovery instrumentation station. The No. 1 and No. 2 mobile stations can be deployed at any convenient location to provide supplementary TT&C and instrumentation capabilities for the satellite TT&C network. The main equipment of these mobile stations includes the VHF/UHF unified TT&C unit and the mobile monopulse radar. The monopulse radar of the No. 1 mobile station is a digital tracking and instrumentation radar whose performance is comparable to that of the U.S. AN/MPQ-39 radar. The recovery instrumentation station is responsible for tracking the re-entry vehicle of the satellite as it re-enters the atmosphere and for searching and recovering the vehicle. The station is equipped with a recovery instrumentation radar and a helicopter-based radio direction-finding device.

In addition to the TT&C stations, [the Yuanwang] ocean-going instrumentation ships also constitute an important segment of the China Satellite TT&C Network.

II. XSCC

1. Capabilities of the XSCC (or simply the Control Center)

The main capabilities are:

Establishing TT&C plans (also called TT&C strategy) in real-time to carry out automatic scheduling of multi-satellite (six satellites) TT&C functions;

Integrating the satellite/launch-vehicle tracking and telemetry data obtained by the TT&C stations and instrumentation ships and performing real-time processing and post-processing of the data;

Determining the satellite orbit elements and attitude parameters, calculating the satellite ground tracks and broadcasting predicted observations;

Monitoring the satellite operating conditions, generating control commands and monitoring and controlling the operation of the TT&C network;

Carrying out the missions of satellite retrieval and long-term management of long-design-life satellites.

2. Components of the Control Center

The key component of the Control Center is the data processing system; other components include the command and monitoring system, the communications system, the time and frequency system and the safeguard/protection system. Pictures of the Control Center main building and the command center are shown in Figure 1 and Figure 2, respectively [photographs not reproduced]. In this article, only the major components (e.g., the data processing system) are introduced.

(1) Data Processing System

The data processing system consists primarily of the computer hardware and the TT&C applications software.

The computer hardware includes three NCI-2780 computers, two VAX-8700 computers, several VAX-II computers and a large number of peripheral equipment pieces. The three NCI-2780 computers and the two VAX-8700 computers are linked by Ethernet to form a local area network (LAN). Physically, the five computers form a VAX cluster using CI links connected to a star coupler; logically, two of the NCI-2780 computers operate in the duplex mode outside the cluster to serve as front-end computers. Communications between the computers is accomplished via Ethernet and CI links; the two redundant links provide enhanced system reliability and processing capability. The two front-end computers are connected to computers at the TT&C stations via the communications control processor (CCP) and the communications links to form a long-range computer network.

The TT&C applications software can be divided into two categories: LEO satellite TT&C software and geosynchronous satellite TT&C software. Functionally, they can be divided into four different types: a) real-time software, which includes software for information exchange, orbit calculations and predictions, attitude calculations, control command calculations, monitoring and display; b) post-processing software, which includes software for processing tracking and instrumentation data and telemetry data; c) multi-satellite TT&C software, which includes software for generating multi-satellite plans, multi-satellite automatic scheduling, man-machine interface, and system distribution and management; and d) simulation software, which includes software for simulating the operation of the TT&C network and satellite dynamics.

(2) Command and Monitoring System

The command and monitoring system consists of the voice-activated scheduling and assignment unit, the programmable command unit, and the special monitoring and display unit. The monitoring and display unit contains the main processor, the display processor, the video distributor, the display terminals (display screens, large-screen projectors), the keyboard and the hard-copy machine. It has the capability to display graphics, images, word characters and curves, and to perform picture enlargement, reduction, superposition and scanning, as well as man-machine interaction.

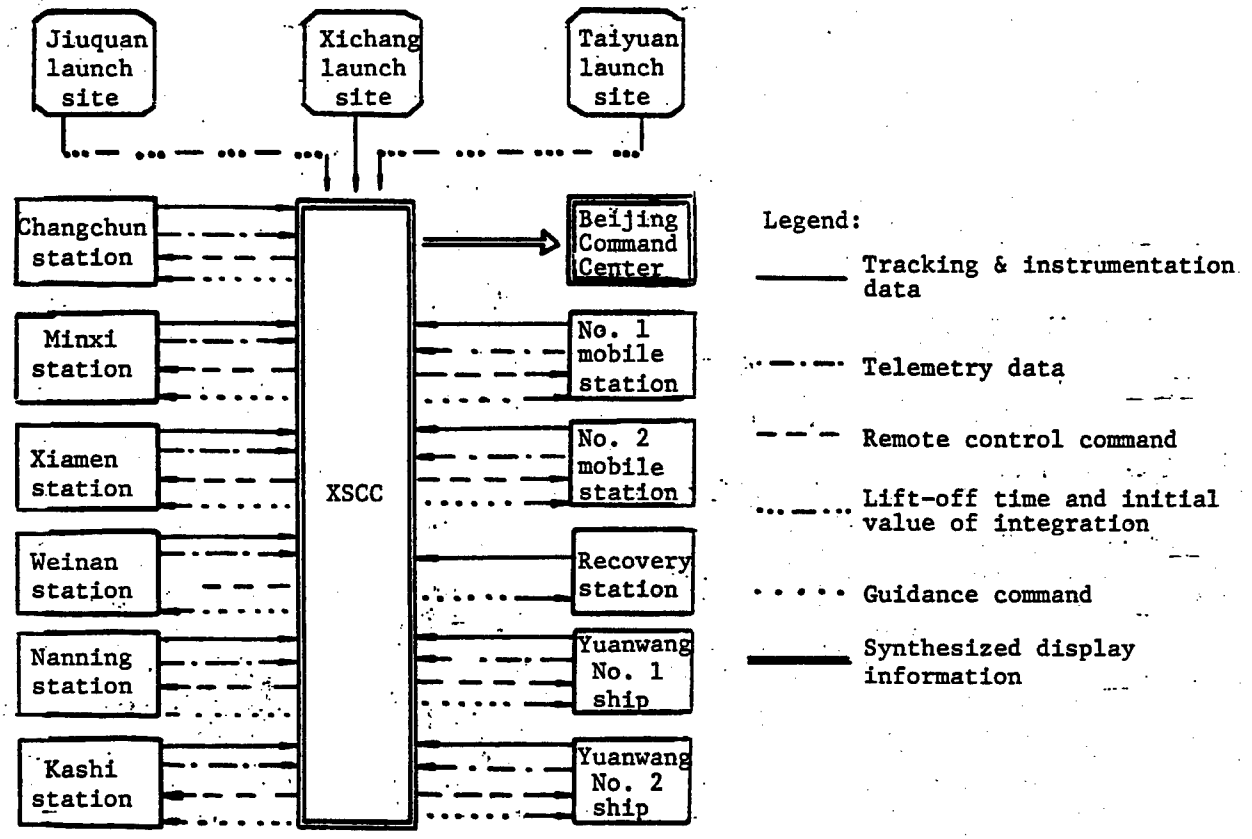

Figure 3. Information Exchange Between the XSCC and the Launch Sites, TT&C Stations (and Ships)

In addition to the many display screens provided for the command and analysis staff, the command center also has five large-screen projectors. The screen is 3 x 2.2 (m^2) in size and made of tiny glass beads.

(3) Communications System

The communications system consists of wired communications equipment, wireless single-sideband communications equipment and satellite communications earth stations. The earth stations include a 13-m station and a 12-m station which can communicate with both domestic and international communications satellites. Such a system can be readily linked with existing foreign TT&C networks.

3. Information Exchange Between the Control Center and Other Organizations

Information exchange between the XSCC and the launch sites, the TT&C stations (and ships) is depicted in the diagram shown in Figure 3. Communication is based on the high-level data link control (HDLC) protocol.

III. Key Issues of Satellite TT&C

From 24 April 1970, when China launched its first satellite, the Dong Fang Hong, until the end of 1990, the China Satellite TT&C Network successfully completed TT&C missions for 30 satellites. In this section, the key issues of TT&C performed by the XSCC, and its TT&C stations are illustrated by the examples of TT&C functions for recoverable remote-sensing satellites and geosynchronous communications satellites.

1. TT&C of Recoverable Remote-Sensing Satellites

Orbit-injection segment: The Control Center transmits guidance information to the TT&C stations, where satellite tracking data and telemetry data are received and demodulated, and transmitted back to the Control Center in real time.

The Control Center makes an assessment of the status of satellite orbit injection and determines the initial orbit parameters. If necessary, the Control Center can command the TT&C stations to initiate satellite control.

Operation segment: During every orbit pass when the satellite is in view, the Control Center assigns the appropriate TT&C stations to perform tracking and measurement, and to receive and demodulate the telemetry data; the data are processed in real time by the Control Center.

The Control Center also assigns the TT&C stations to control the satellite, which includes injecting data into the onboard computer. At the end of every orbit pass, the Control Center performs calculations to obtain improved orbit elements, improved orbit predictions and recovery point. The calculations are carried out using advanced and mature techniques to achieve high accuracy.

Recovery segment: During the orbit prior to reentry, commands are sent by the Control Center to the TT&C stations to initiate the satellite recovery sequence.

Control of satellite recovery is accomplished jointly by the TT&C network and the onboard control system. When the satellite enters the reentry orbit, the Control Center sends instructions to the No. 1 and No. 2 mobile stations to issue attitude-adjustment commands and module-separation commands (separation of the instrument module and reentry module) to the satellite. After module separation, the instrument module continues to travel along its orbit, whereas the reentry module enters the atmosphere under the control of the TT&C system.

Upon entering the atmosphere, the parachute system of the reentry module is activated, which slows down its descent. The recovery instrumentation station located in the central part of Sichuan Province uses direction-finding equipment on board a helicopter and a ground radar to predict the coordinates of the impact point of the reentry module. Once the reentry module has landed, it is retrieved jointly by the recovery instrumentation station and the participating research and development organizations.

The 12 recoverable remote-sensing satellites launched by this country have all been successfully recovered. This demonstrates the capability of China's satellite TT&C system in performing accurate and reliable recovery measurements, calculations and control.

2. TT&C of Geosynchronous Communications Satellites

Powered-flight segment: The Control Center collects the tracking data and telemetry data from the TT&C stations (ships), and monitors the flight conditions of the launch vehicle in real time.

Transfer-orbit segment: During transfer orbit, the Control Center performs repeated calculations of the orbit elements, attitude parameters and spin velocity of the satellite using tracking data and telemetry data (including both analog telemetry and coded telemetry) obtained from the TT&C stations (and ships). If necessary, the Control Center can also calculate the control commands and transmit them to the TT&C stations; control of the satellite at the TT&C stations is accomplished by using remote-control and synchronous-control equipment. The purpose of satellite control, which includes orbit control, attitude control and spin-velocity control, is to prepare the satellite for apogee-motor ignition.

At the apogee point of the "ignition orbit," the Control Center sends instructions to the TT&C stations to issue an apogee-motor ignition command. Upon ignition of the apogee motor, the satellite gains sufficient velocity to leave the elliptical transfer orbit and enter the pseudo-geosynchronous orbit.

Pseudo-geosynchronous orbit segment: By applying orbit control, the satellite acquires a velocity increment to begin drifting toward its designated station. When it reaches the station, a "station capture" control command is issued to achieve the desired geosynchronous orbit.

Geosynchronous orbit segment: A remote-control command is transmitted to the satellite to activate its transponder. "In-orbit tests" are conducted by the TT&C system and the satellite communications system.

During its design life, the satellite is under long-term TT&C management, which includes satellite station-keeping, attitude maintenance, operation control and energy management during eclipse.

The China Satellite TT&C Network has fully demonstrated its TT&C capability for geosynchronous satellites in terms of accuracy, reliability, automation and information utilization.

A Method for Calculating Longitudinal and Lateral Aerodynamic Characteristics of Tactical Missiles

40100024A Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese Vol 9 No 4, Dec 91 pp 394-401

[English abstract of article by Zhu Guolin and Huang Changyou of China Aerodynamics Research and Development Center; MS received 27 Mar 90, revised 30 Apr 91]

[Text] A method for calculating longitudinal and lateral aerodynamic characteristics is presented for conventional and canard configurations of tactical missiles at high angle of attack and high yaw angle; this is the method of combining numerical computation with engineering calculation. The aerodynamic characteristics of the potential flow are obtained by solving linear partial differential equations, while nonlinear aerodynamic characteristics due to viscosity are obtained using the calculation of the shed-body vortex system. The effects of near-distance and far-distance interference between wings and tails are considered in this method. The longitudinal and lateral aerodynamic characteristics of tactical missiles for the conventional and canard configuration can be calculated using this method at Mach number range from 0 to 3.5, angle of attack and yaw angle from 0 to 20 degrees. The computational results and experimental data are in reasonable agreement.

An Efficient Finite Difference Scheme for Computation of Axisymmetric, Transonic Full-Potential Flows Over Bodies of Revolution

40100024B Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese Vol 9 No 4, Dec 91 pp 410-417

[English abstract of article by Zhang Li and Huang Mingke of Nanjing Aeronautical Institute; MS received 28 Apr 90, revised 20 Nov 90]

[Text] Fast and accurate estimations of pressure distributions and wave drags around blunt or pointed bodies of revolution in transonic flow of practical importance for the aerodynamic design of aircraft, missiles and many shapes of classical and practical interest. This paper studies the finite difference numerical method for the solution of conservative full-potential equations with exact boundary conditions for general axisymmetric bodies in inviscid, steady transonic flow. The nearly orthogonal body-fitted "C" grids, obtained by the combination of conformal mapping technique and sheared coordinate transformation, are used in the computation. It is found that the difference between governing equations of axisymmetric flow and 2-D planar flow is that ρ in governing equation of 2-D planar flow is replaced by ρy, where ρ is isentropic density and y is the radial distance from the body axis. But, if we do the same as 2-D iteration scheme AF2 to get axisymmetric AF2 scheme, the iteration will be divergent. In this paper, the reasons for divergence are analyzed and a highly efficient algorithm of finite difference method AF2 designed to solve conservative full-potential equation for axisymmetric transonic flow has been developed according to the optimum convergence conditions. This axisymmetric AF2 scheme developed has been applied to hemisphere-cylinder, missile forebody and a wide variety of blunt and pointed bodies of revolution. Unlike other methods which can only be applied to subsonic free streams, the present method can treat subsonic, transonic and low-supersonic free streams. Numerical results of the surface pressure distribution, including subsonic, transonic and supersonic cases, are presented for hemisphere-cylinder and missile forebody. All calculated examples show that the present AF2 scheme yields very good convergence rate and that the results obtained agree very well with available experiments and other theories.

Breakthrough in Counter-EMP Research

92P60141A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 17 Jan 92 p 3

[Article by Zhao Changguo [6392 7022 0948]: "Breakthrough Advances in Counter-Electromagnetic-Pulse Research"]

[Summary] Researchers from the Nanjing Engineering Institute of the PLA General Staff Engineering Corps Department have developed China's first mobile, multi-functional electromagnetic pulse (EMP) simulator and measurement system, which was certified on 4 December 1991. This new state-of-the-art simulator—designed to be used for battlefield testing of EMP penetration and EMP-resistant shielding materials within a 10-meter natural protection layer—has a single-loop, high-density structure, with non-peaking capacitors, a small light-weight pulsed high-voltage source, and two modularized electric-field radiators. The measurement system includes a radio link to a general-purpose mainframe computer which can quickly perform parametric analyses of the electric-field distribution, a high-voltage pulsed voltage divider with an intrinsic standoff ratio of 2×10^4 and a response time of under 2 nanoseconds, a magnetic-field transducer, a calibrator, and advanced fiber optic transmission and data processing systems.

Shenzhen-Hong Kong Cooperation in Biotechnology Discussed

92FE0118A Beijing ZHONGGUO KEJI LUNTAN [FORUM ON SCIENCE AND TECHNOLOGY IN CHINA] in Chinese No 5, Sep 91 pp 21-23

[Article by Wang Wei [3769 3555]]

[Text] In the development of high-tech industry in today's world, the electronic information technology is branded the lead and new materials are regarded as the basis; in that sense, biotechnology should be called the core. This is because (1) the development of bioengineering and technology is vital in the solution of major problems in population, food, resources, environment and health care, (2) the development of biotechnology is based on the utilization of regenerative biological resources and promotes the full use of available resources, and (3) the development of biotechnology will dispel the traditional view of material production, energy consumption, and information processing, and promote fundamental changes in the industrial structure, product make-up, and technology system. Begun in the 1930's, bioengineering and technology have found widespread application in medicine, energy, food, vegetation and pollution control. It has also produced a host of new, practical and efficient products with enormous economic and social benefits. Statistics showed that the value of biotechnology products in the world in 1990 reached US$30 billion. Of the total, $9.4 billion were in energy, $5.7 billion in agricultural products, $3.7 billion in foods, $2.8 billion in medical products, $2.6 billion in plastics, $2.5 billion in chemicals, and $3.3 billion in other products.

After studying the development in Shenzhen and Hong Kong, we believe that both places are faced with a choice in biotechnology. Shenzhen and Hong Kong are separated by a river and have long geographical, historical and social ties. In recent years, as the economic interaction increased between the two cities, so did the technological cooperation. Faced with the challenges in the 1990's in world economic structure and high technology development, both cities must adjust their industrial structure, develop new businesses, promote technological advances, and develop a new generation of products. In view of this situation, this author believes that cooperation between Shenzhen and Hong Kong in biotechnology is not only feasible but also potentially prosperous.

I. The Great Potential of the Future Market

1. Pharmaceutical Products for Treatment of Difficult Diseases and for Health Care

Biotechnology has been used here and abroad in the development of drugs used in the treatment of hepatitis, cardiovascular diseases, and tumors. Clinical tests have shown that a number of the drugs were quite effective. Biotechnology may also be used in the production of anti-aging, cosmetic and health products that contribute to the improvement of the quality of life. The combined population of Shenzhen and Hong Kong is almost 10 million people. The health and social needs of this large population are conducive to the growth of biotechnology here. First, the life expectancy has increased because of the improved standard of living and medical care. But at the same time the increase of cardiovascular diseases and Alzheimer's disease is a social phenomenon that cannot be ignored. Drugs developed with biotechnological methods are effective and without side effects, which makes them very popular among the people. Second, Shenzhen and Hong Kong are both highly urbanized, with crowded dwelling and traffic. The pollution and noise in this urban setting have caused some to develop "modern cultural syndromes" such as nervous dysfunction. Such diseases may benefit from biotech drugs. Third, as the societal and aesthetic views change, the demand on cosmetic, nutritional, and tonic products is increasing with time, particularly in Shenzhen and Hong Kong. With the high purchase power of the residents in the two cities (the predicted 1997 GNP is US$18,000-20,000 for Hong Kong and US$5,000 for Shenzhen), these types of products have a bright future.

2. Application in Environmental Protection and Urban Waste Management

Biotechnology has been successfully used in foreign countries to treat city and industrial wastes. For example, cellulose may be extracted from wood chips, waste cotton products and leather wastes by biotechnological methods. The cellulose may be decomposed to obtain a syrup, which is then converted into methane by fermentation, thus converting a waste into fuel and raw material. Specially cultured bacteria may be used in the treatment of waste liquids or oils released by chemical, textile and electroplating plants to extract useful material through decomposition and fermentation. A review of the industrial situation and urban environment of Shenzhen and Hong Kong shows that, although Hong Kong has undergone several years of economic adjustment and moved some textile, apparel, plastics and toy industries to the Chinese inland and to Southeast Asia, the mainstay of the Hong Kong economy is still in processing and manufacturing. The large quantity of wastes produced by the manufacturing industry, together with the wastes generated by urban living, are threatening the crowded city. In recent years Shenzhen has established more than 10,000 enterprises (including several thousand "three and one" businesses in Baoan County), a great percentage of these industries are heavy polluters. In the readjustment of the industrial structure and in the development of the third industry, pollution prevention and beautification of the city have been placed on the agenda. Since Shenzhen and Hong Kong have a common need in environmental protection and industrial waste treatment, they can do well in collaborating in biotechnology.

3. Development of New Energy Resources

As the primary energy resources in the world dwindled, people have sought new resources of energy. Ethanol may be produced by biotechnological means as an important chemical raw material and as a potential fuel. For example,

Brazil made use of its high yield of sugarcane and produced ethanol from sugarcane waste. Mixed with gasoline, it solved more than half of Brazil's automobile fuel problem. Also, scientists are investigating hydrogen energy sources using solar and ocean energy. Both hydrogen energy and biomass energy are important to energy-starved Shenzhen and Hong Kong. (Today Hong Kong imports almost 100 percent of the energy it consumes.) In terms of new energy resources, Shenzhen and Hong Kong have endless supply of seawater and sunshine, the Zhujiang delta near Shenzhen is rich in sugarcane and other fiber-rich vegetation. Even though a number of countries have invested to build oil refineries in Shenzhen and Huizhou, the development of regenerative energy resources by biotech means is still a good way to supplement and modulate conventional sources of energy.

4. Technological Improvement of Traditional Industries

Faced with fierce international competition, Shenzhen and Hong Kong took on the heavy responsibility of improving traditional industries technologically. An important step is to make timely use of biotech in traditional enterprises. For example, plant protein may be used as the raw material for producing protein fabrics with greater strength. In the plastic processing industry, biological materials may be used in the production of biodegradable and edible plastics for packaging traditional foodstuff. Biological chips or elements may further improve the technological performance and lower the cost of electronic components. This last item is highly significant to Shenzhen and Hong Kong because of the strong electronics industrial base at the two cities.

II. Current Development Status

Shenzhen and Hong Kong are very sensitive to economic and technical development abroad. Hong Kong relies heavily on the international market and has a strong desire to track the international trend in high-tech development. As a new development zone, Shenzhen pays great attention to high-tech development from the beginning. In 1990, the high-tech value of production accounted for 10 percent of Shenzhen's total industrial value of production, and in the high-tech production, biotechnology accounted for 20 percent. At present, the development characteristics of biotechnology and technology industry in Shenzhen and Hong Kong are as follows:

Hong Kong

—Fundamental research and applied research in biotechnology are emphasized, some of the research results have reached the world's state-of-the-art. The approaches are: (1) Jointly develop research with advanced countries of the world, (2) develop new technologies for cross-country biotech companies, and (3) develop some applied research based on the reality in Hong Kong.

—To establish high caliber comprehensive biotechnology research institutes. In 1989 Hong Kong invested more than HK$100 million to build up the Hong Kong Laboratory of Biotechnology (HKLB) on a site occupying 31,000 square meters. The R&D contents include: development of bioengineered new drugs and diagnostic reagents, development of new drugs based on Japan's oriental medicine and Chinese medicinal concepts, development of high nutrition, high efficiency foods, and treatment of waste water and public hazards with biotech. This laboratory has now become the mainstay in Hong Kong's bioengineering and biotechnology.

—Small-scale biotech enterprises scattered in the region will be difficult to develop.

Shenzhen

—Preferential policies are conducive to the development of bioengineering and biotechnology. The Shenzhen municipal government has made industrial structure adjustment and high-tech development a priority of the economic endeavor of the 1990's, and has formulated preferential policies to go with it. Research and industrial development in biotechnology will enjoy an exemption in product tax, a higher rate of equipment depreciation, opportunities to go to Hong Kong or overseas, and simplifies steps in important and exporting equipment. In addition, an award foundation was also established.

—A number of biotech production entities were tentatively established. Today, Shenzhen has about a dozen medium-sized biotech industries and the quantities have reached the medium provincial level.

—The technical capability and production components are based on the inland of China. Today, more than 90 percent of the biotech results and more than 98 percent of the biotech personnel came from the inland of China. The environmental conditions and preferential policies in Shenzhen are attractive.

A comparison of the bioengineering and biotechnology development in Shenzhen and Hong Kong reveals their respective unique features. The fundamental research and applied research in Hong Kong are close to the international standard, but the developmental and producing capability is not strong. Shenzhen has formed a group of medium-sized production enterprises, but the fundamental capabilities are lacking. Therefore, a cooperation between the two cities will be mutually beneficial.

III. A Complementary Cooperation Structure

Based on the analysis above, a comprehensive, in-depth, complementary cooperation will not only be to the best interest of both Shenzhen and Hong Kong and their unified economic development, but it is also in keeping with the scientific and economic laws of technological development. The author envisions the following cooperation structure:

1. On the basis of a common cause, conduct unified planning and close coordination to strengthen basic and applied research. Hong Kong has a high standard base for fundamental research in biotechnology, and Shenzhen has the backing of a dozen universities and research institutes

in China. If the two sides work together to make full use of this impressive force, a well-equipped high standard bioengineering and biotechnology research organization may be built in Shenzhen (which has better land and space resources than Hong Kong). Under unified planning and close coordination, basic and applied research will be jointly developed. The institute will surely become a center for biotech research in Southeast Asia. Some of the applied research results will enter the international market based on their advanced nature, timing, and applicability.

2. To strengthen the conversion mechanism and quickly enter the research results into commercialization. In terms of the commercialization of the biotech results, Shenzhen is in a better position than Hong Kong. First, Shenzhen already has more than 10 biotech enterprises and a certain level of production ability. Second, Shenzhen has better conditions for construction. The cost for industrial land in Shenzhen is 1.6 yuan per square meter and the land use fee is waived for high-tech enterprises for the first five years. In Hong Kong, however, the cost for industrial land is as high as HK$400 per square meter. Institutes like the Hong Kong Laboratory of Biotechnology were built on land reclaimed from the sea, and the resulting investments were enormous. In terms of the financial resources for commercializing biotech research results, Hong Kong is superior to Shenzhen. Hong Kong is well connected in the financial world. To hasten the conversion of biotechnology results into products, Shenzhen and Hong Kong can complement each other on land, labor and resources. By a combination of joint venture, partnership, and sole proprietorship, a small production zone should be built in Shenzhen and the public utilities should be perfected. High level biotech enterprises with special expertise should be established. Current business will be expanded and converted. These activities will undoubtedly open up a new vista for bioengineering and biotechnology.

3. Based on local market, aggressively expand into the domestic Chinese market and international new market. The short-term goals of the Shenzhen-Hong Kong cooperation in biotechnology are: produce effective, new drugs, low fat foods, anti-aging and cosmetic health-care products, treat urban wastes and pollution, develop new energy resources, and develop function-specific new products by applying biotech to traditional industries. The primary clientele are the 10 million people in Shenzhen and Hong Kong and their consumption needs. As the cooperation progresses and the scale of the business increases, the second service target will be the 1 billion inland population in China. The goal will not only be providing products, but will also be environmental improvement. The final goal of the Shenzhen-Hong Kong biotech cooperation is to raise the research to the top international level and introduce the products and technologies into the international market for higher reputation and profit. To this end, there must be careful planning and solid work, and an efficient utilization of Hong Kong's information and market connections. We firmly believe that the intelligent Chinese people can definitely reach this goal.

Protein Analysis of a Virus Isolated From the Patient's Feces With Hepatitis E in China

40091009A Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese Vol 16 No 6, Dec 91 pp 407-410

[English abstract of article by Yuan Xitong [5373 6932 0681], Huang Rutong [7806 1172 4827], et al. of the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing]

[Text] A strain of 87A virus was isolated from fecal extract of a patient with epidemic enterically transmitted non-A, non-B hepatitis. It has been identified as hepatitis E virus (HEV) after a series of appraisements. The virus was inoculated into 2BS cell. The suspension of cultured virus was purified by PEG-6000 precipitation and by 10-40 percent sucrose density gradient centrifugation. Purified virus particles were analysed by SDS-PAGE and Western blotting with patient's sera obtained from Xinjiang and Beijing. Two regions of specific proteins have been detected. One was the region of 70-80 kD in MW, and other in 30-40 kD. The results indicate that the strain of 87A virus is probably the Calicivirus.

The Nucleotide and Encoded Amino Acid Sequences of the Structural Protein Gene of D_2-04 Virus Strain Isolated in China

40091009D Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 341-344

[English abstract of article by Yang Peiying [2799 0160 5391] of the Department of Virology, Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, Beijing and Lam SK of the Department of Medical Microbiology, University of Malaya]

[Text] The nucleotide and encoded amino acid sequences of the nonstructural protein NS1 gene of D_2-04 virus strain has been previously reported. In this paper, the nucleotide and encoded amino acid sequences of structural protein gene of D_2-04 virus strain are analyzed.

The results showed the structural protein gene of D_2-04 virus strain contained 2325 nucleotides, encoding 3 structural proteins: the capsid (C), membrane precursor (prM), membrane (M) and envelope (E). A total of amino acids were 775. The number of nucleotide of protein C, prM (M), E gene were 342, 273 (225) and 1485, respectively. The number of amino acids were 114, 91, 75 and 495, respectively.

From comparative sequence analysis, we found that envelope protein E were highly conservative. There were 3 conservative peptides of 14 (98-111), 8 (371-378) and 7 (416-422) in the region of envelope E. The homology of nucleotide sequences of protein E were 95.0 percent, 97.4 percent and 90.0 percent with NGC, JAM and S1 strain, respectively. The similarities of amino acid sequences were 96.8 percent, 97.2 percent and 91.4 percent with NGC,

JAM and S1 strain respectively. The similarities of amino acids of protein C were 94.8 percent, 95.6 percent and 92.3 percent; prM (M) were 94.9 percent (92.9 percent), 93.7 percent (92.0 percent) and 89.0 percent (87.1 percent) with NGC, JAM and S1, respectively.

These results revealed that D_2-04 strain were more similar to NGC and JAM than S1. Among 3 structural proteins, protein E is a highly conservative protein. C was more conservative, prM (M) was less conservative.

Studies on the Serotyping of EHF Virus Isolated in Guizhou Province

40091009E Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 351-354

[English abstract of article by Wang Zhaoxiao [3769 2507 1321], Fu Deqing [0102 1795 1987], et al. of the Sanitary Anti-Epidemic Station of Guizhou Province]

[Text] Twenty-seven virus strains of EHF were isolated from the rodents and patients in the endemic area and potential endemic area of wild rat-type and house rat-type EHF in Guizhou. They could be steadily passaged in the brains of suckling mice. Typing of these EHF virus strains were studied by HI, NT with McAb. It was found that the NT with McAb for typing was better. EHF viruses of Guizhou could be divided into two serotypes which are consistent with the type I and type II EHF viruses from other epidemic areas of Asia. This study showed that A. agrarius carried only type I EHF virus and R. norvegicus carried type II or type I EHF viruses. Q83 strain might have unique antigen component which we have not known. The antigenic analysis of 27 virus strains of EHF by using McAb showed that there would be at least 24 kinds of different antigenic determinants.

Fatty Acid Analysis in Lyme Disease Spirochetes Isolated From Ixodes Persulcatus in China

40091009F Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 359-361

[English abstract of article by Zhang Panhe [1728 3140 3109], Wu Xiaoming [0702 2556 2494], et al. of the Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences]

[Text] Fatty acids in five strains of Lyme disease spirochetes isolated from Ixodes persulcatus in China were analysed by gas chromatography (GC) and compared with the fatty acids of the standard strain B_{31} Leptospira. It was found that the constituents of fatty acids in Lyme disease spirochetes were similar—palmitic acid and oleic acid as the main fatty acids, and accounted for about 80 percent of the total fatty acids. The constituents of fatty acids in Lyme disease spirochete and Leptospira are different. Palmitic acid, oleic acid and linoleic acid were the main fatty acids of Leptospira, and accounted for about 70 percent of its total fatty acids.

High Level Expression of HIV-1 gp120 Protein in E. Coli

40091009G Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 393-396

[English abstract of article by Wu Weixing [0702 5898 2502], Zhang Wei [1728 4850], et al. of the Institute of Basic Medical Sciences, Academy of Military Medical Sciences, Beijing]

[Text] Binding of the external envelope protein gp120 with the viral receptor CD4 is the first event of infection of $CD4^+$ T helper/inducer cell by HIV. Anti-gp120 antibodies are detected in HIV-infected individual and AIDS patient's serum. Antiserum and McAbs to gp120 have the capacity to neutralize HIV infection in vitro. Therefore, recombinant gp120 products can not only be used as diagnostic tool for HIV infection, but also be a possible candidate of subunit vaccine to HIV. We cloned two gene segments encoding respectively the NH2-terminal half and COOH-terminal half of the gp120 envelope protein into the expression vector pEX31. These inserts resulted in high level expression of recombinant fused gp120 proteins in E. coli. Western blot results showed that the expressed proteins could be recognized by the specific antibodies in AIDS patient's serum. The expressed products which were in the form of inclusion bodies in bacterial cytoplasm could be purified to 70 percent by simple washing. ELISA indicated that the partially purified antigens could be used as the coating reagent to detect antibodies in HIV-infected serum.

Retroviral-Mediated Transfer of the Human IL-2 Receptor Gene Into Murine Fibroblasts

40091009H Beijing ZHONGHUA WEISHENGWUXUE HE MIANYUXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 397-400

[English abstract of article by Wang Jianan [3769 1696 1344], Zhu Yuanxiao [2612 0337 2556], et al. of the Institute of Basic Medical Sciences, Academy of Military Medical Sciences, Beijing]

[Text] Expression of IL-2 receptor gene in the mammalian cells has been obtained with the retroviral vector-mediated gene transfer method. We used NTK-12, a retroviral vector containing the human IL-2 receptor gene, to transfect amphotropic and ecotropic virus packing cell lines by electroporation. Subsequently, cell-free culture supernatant was used to infect murine fibroblast NIH3T3. Indirect immunofluorescence and APAAP immunocytochemical stainings showed that the human IL-2 receptor gene has been stably expressed in the murine fibroblasts. Thus, it can provide a new approach for research on molecular structure and function of IL-2 receptor gene, identification and screening of anti-IL-2 receptor McAbs.

Effect of Complement Depletion by CVF on Humoral Immunol Reaction

40091009I Beijing ZHONGHUA WEISHENGWUXUE HE MIANYIXUE ZAZHI [CHINESE JOURNAL OF MICROBIOLOGY AND IMMUNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 401-403

[English abstract of article by Wu Yaosheng, et al. of the Department of Biochemistry, Guangxi Medical College, Nanning]

[Text] The complement in guinea pigs can be deeply depleted by cobra venom factor (CVF) separated from Naja naja atra (Chinese cobra venom). The primary response in guinea pigs immuned with sheep red blood cell (SRBC) after decomplemented with CVF was suppressed and the immunosuppression was related to the dose of antigen and the route of immunization. The suppression effect of CVF was unobvious when very low dose of antigen was given by ip; whereas with suitable dose of antigen, the immunosuppression by CVF was very obvious, and mainly hemolytic Ab was suppressed; increasing the dose of antigen resulted in little or no evidence of immunosuppression. The humoral immuno-response was more apparent when immuned by iv, but was suppressed more obviously by CVF. Complement plays the role helping B cell only within certain dose limits. The complement depletion by CVF suppresses humoral immuno-response by depletion of C3.

Strengthening Hepatitis Control Urged

92FE0118C Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 13 No 9, Sep 91 pp 58-59

[Article by the Work Department of the Chinese Society of Scientific Association]

[Text] Editor's Note: China has made considerable progress in the control of viral hepatitis in the Sixth Five-Year Plan and the Seventh Five-Year Plan. But the epidemic of hepatitis in China is still rampant. To discuss the control of this disease, more than 200 experts and scholars of the 18 national societies of the Chinese Scientific Association (led by the Chinese Medical Society) and of local scientific associations met in Guangzhou 1-4 April 1991. The epidemic situation of viral hepatitis in China was discussed and control measures were proposed.

Present Situation of Viral Hepatitis in China

Viral hepatitis may be divided into at least five types, namely hepatitis-A, -B, -C, -D, and -E. China is a high occurrence area for hepatitis and has all five types. According to disease reports, the annual average viral hepatitis cases is 120 per 100,000 population. There have been frequent epidemic breakouts in recent years.

In January to March 1988, Shanghai had the largest hepatitis-A epidemic in medical history, with a total number of cases of 310,000 and 47 deaths. Preliminary data showed that the epidemic cost the city 508 million yuan in direct economic loss and 557 million yuan in indirect loss, with a combined total loss of 1.065 billion yuan. From 1986 to 1988, there was a hepatitis-E epidemic in southern Xinjiang that spread over three regions and 23 cities. That epidemic lasted 20 months, with a total number of cases equal to 120,000 and 707 deaths. These two epidemics caused China heavy economic and social losses.

Based on estimates in epidemic surveys, there are at least 700 million Chinese with hepatitis-A, 600 million Chinese being infected with hepatitis-B and about 120 million hepatitis-B carriers; about one in four cases will eventually develop into chronic liver diseases including cirrhotic liver cancer and primary liver cancer. There are about 12 million chronic hepatitis patients in China. Each year about 300,000 die from liver diseases, half of them from primary liver cancer. A great majority of them are related to contracted hepatitis-B or hepatitis-C. Especially serious is that 40 percent of mothers carrying hepatitis-B may transmit the virus directly to their infants. After the newborns contract hepatitis-B, they tend to develop into chronic virus carriers. In China there are about 800,000 to 1 million newborns becoming hepatitis-B carriers; a portion of them will have hepatocirrhosis or primary liver cancer after they became adults. According to 1988 Shanghai data on outpatient and hospital fees of viral patients, the costs are 1,131.52 yuan per patient with acute hepatitis, and 1,673.92 yuan per patient per year for chronic hepatitis, and 5,115.70 yuan per patient for liver cancer patients. Based on the number of hepatitis and liver disease patients in China per year, 1.2 million acute hepatitis patients spent 1.358 billion yuan, 12 million chronic hepatitis (including cirrhosis of liver) patients spent 20.087 billion yuan, and 160,000 liver cancer patients cost China 819 million yuan. The direct economic loss associated with the three liver diseases above is about 22.264 billion yuan per year.

Major Problems in the Control of Viral Hepatitis

1. Hepatitis-B Vaccination Was Not Included in the National Immunization Program

The vaccination of viral hepatitis is an important preventive measure. China succeeded in the development of hepatitis-B vaccine during the Sixth Five-Year Plan. Today, hematogenous vaccines for hepatitis-B can be mass produced and genetic-engineered vaccines are being tested. If there is a vaccination plan to vaccinate all the newborns, then the control of hepatitis-B will be enhanced in the second and third generations. However, the high cost of the vaccine and problems in the supply channel have prevented the general use of vaccines. Moreover, lack of funds in the Ministry of Health makes the implementation of a national vaccination program quite difficult.

2. The Lack of Unified Coordination and Management in the Improvement and Monitor of Environmental and Food Sanitation

Based on epidemiological data, the spread of hepatitis-E in Xinjiang during 1986-1988 was caused by fecal contamination of the water source. The epidemic of hepatitis-A in Shanghai during January to March 1988 was caused by

eating uncooked contaminated clams. These two epidemics revealed serious flaws in China's environmental, food and personal sanitation and the lack of unified coordination and management.

3. Spread Through the Hospital Is Still Serious

In large city hospitals attention is given to sanitation and disinfection. In some medical units, especially lower and rural medical units, disinfection of medical instruments is not practiced rigorously, nor is the system of one patient, one needle and one syringe. There is a high occurrence of post transfusion hepatitis. The spreading of hepatitis through the hospital is still quite serious.

4. Lack of Effective Treatment and Medication

So far there have not been effective treatment and drugs for viral carriers and hepatitis patients. The carriers remain in the society over a long period of time and become the major source of infection.

5. Lack of Understanding of Newly Discovered Hepatitis-C and -E

Due to a lack of publicity, hepatitis-C and -E were not well understood by medical workers and the general population. Furthermore, scientific research is falling behind and specific testing agents have not been developed. Imported testing agents are very expensive, which prevented timely diagnosis and treatment of the disease. The screening of blood donors and blood products is very limited and there is simply no screening for hepatitis-C. As a result, there have already been hepatitis-C cases infected through transfusion.

Measures To Strengthen the Prevention of Viral Hepatitis

1. Recommend the State Council To Form a Hepatitis Control Coordination and Leadership Group

The control of viral hepatitis involved finance, agriculture, environment, commerce, food, health and research departments. We recommend the establishment of State Council leadership group to coordinate the prevention effort among the various departments.

2. Promote Vaccination

(1) Today China's annual output of hematogenous vaccines for hepatitis-B has reached 9 million shots. The genetic-engineered vaccines are also in production. So it is possible to include hepatitis-B in the vaccination plan. Based on the situation in China, the vaccination movement may begin in the cities and then gradually reach the rural areas. In more developed regions the vaccination can be on a full basis. All the newborns should be vaccinated first and, where possible, pre-school children should also be vaccinated. Vaccine-producing departments should lower the price of the vaccines and prevent the circulation of vaccines through commercial channels. We recommend that financial departments of the central and local governments should make appropriations to provide the necessary money for the hepatitis-B vaccination project.

(2) Attenuated live vaccine for hepatitis-A should be put into production as soon as possible. The safety and the effectiveness of the vaccine should be carefully monitored.

3. Strengthen the Monitor of Sanitation

(1) Improve the disinfection and isolation system. In treatments and preventive injections, the system of one patient, one needle, and one syringe must be practiced vigorously. Strive to achieve across-the-board use of one-time syringes. Sanitation and prevention departments should step up their monitoring and inspection of hospitals and the service profession.

(2) Step up the management of blood donors and blood products. Screen blood donors for hepatitis-B surface antigen with sensitive methods. Establish a test for hepatitis-C as soon as possible and screen blood donors for hepatitis-C. Improve the management of blood products such as plasma, albumin, and γ-globulin to prevent transfusion hepatitis.

(3) Responsible administrative departments should formulate regulations to systematically improve the sanitation facility, the waste water treatment method, and the supervision of food sanitation. The management of aquatic products should be given special attention. Rural and frontier regions should begin to treat human wastes as soon as possible. The management of water sources and the sanitation standards of drinking water must be handled rigorously.

4. Step Up the Pace of Research

(1) We recommend an increase of research funding for viral hepatitis and more active studies of the pathogenesis, epidemiology, disease mechanism, animal model and prevention of different types of hepatitis, especially -C and -E. The study of hepatitis-C and -E should be included in the Eighth Five-Year Plan and laboratory diagnostic methods should be established for these two diseases as soon as possible. In due course, vaccines should be developed. In research, repetition should be avoided.

(2) Put great effort into the development of effective treatment methods, drugs and mechanism for carriers and patients with chronic and severe liver diseases. Combine Chinese herb medicine with Western medicine in the prevention and treatment of viral hepatitis.

5. More Promotion To Gain Attention and Support of the Society

(1) Use broadcast, television, newspapers and popular science columns to inform the society about the spread and danger of hepatitis in China and its preventive measures. Promote the importance and safety of using hepatitis-B vaccines. Raise the level of awareness of the population in hepatitis prevention and treatment.

(2) Establish a viral hepatitis prevention foundation, call for societal support, and raise funds for research and prevention of viral hepatitis.

Measures To Develop China's Biomedical Engineering Discussed

92FE0029A Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 13, No 8, 23 Aug 91 pp 20-23

[Article by Gu Fangzhou [7357 2455 5297]: "A Discussion of Development Paths for China's Biomedical Engineering"]

[Text] The China Biomedical Engineering Society was founded more than 10 years ago. China has made substantial progress in biomedical engineering over the past 10-plus years and accumulated much experience, but we have also had many lessons. What path should we take in the future? This is a major issue that we face.

The discipline of biomedical engineering is not simply the application of engineering technology in biology and medicine. Instead, it involves multidisciplinary comprehensive research centered on understanding human life activity that has a three-level structure at the whole level, the system, organ, and tissue level, and the cellular and biomacromolecular level. Regarding development principles, we proposed starting with concrete realities in China, borrowing from the experiences of others, and taking our own route. We clearly proposed: "our objective is not purely scholarly advances but is instead developing biomedical engineering technology that conforms to China's realities; our focus is not on high-level, precision, and incisive technical equipment but is instead on studying and developing reliable, simple, and economical technical equipment to contribute a force to rapidly raising overall medical levels in China". In one sentence, it involves major efforts to develop "economical" biomedical engineering technology. The development of biomedical engineering in foreign countries and our own practice over the past several years have enriched and deepened our understanding of biomedical engineering, and they have confirmed that our present formulations are correct. We should welcome and encourage many courageous and insightful biomedical engineering workers to base themselves on China's actual conditions and make achievements to satisfy the urgent needs of China's health industry. Shifting from a focus on tracking advanced biomedical engineering technology in foreign countries to the urgent needs of China's pharmaceutical and health industry as a guide is a change of direction. It is required by China's national conditions and is of universal importance.

I. Change Concepts, Take New Routes

Historically, the emergence of biomedical engineering was spurred by two factors. One is the high degree of development of material civilization since industrialization, major changes in people's living environments, working rhythms, and so on, and the growing concern of people for their personal health. The second is rapid progress in space technology, microelectronics technology, and other high technology that has opened new prospects for improving people's life activity processes. With the combination of these two things, biomedical engineering arose as the times required in the developed nations of the West. Huge advances have been made in biomedical engineering over the past several decades and it has absorbed nearly all high technology and new technology for its own use while at the same time forming a huge high- tech industry. Estimates indicate that the yearly output value of the biomedical engineering industry in the United States could reach $100 billion by the year 2000.

Advances in biomedical engineering have led to the emergence of high-tech medical treatment instruments and equipment and created another situation, which is an abrupt rise in the index curve of medical treatment and health care expenditures that are becoming an increasingly heavy burden on society as a whole. This burden has now become so heavy that the economically developed countries of North America, Western Europe, and so on find it hard to bear. In the United States, for example, medical treatment and health care expenditures accounted for 13 percent of GNP in 1990, but were just 1.2 percent 10 years ago. At this rate of expansion, they will reach 28 percent in 2010. This is an unbearable burden on society and the final result will be the bankruptcy of the entire medical treatment and health care system, which would be a disaster.

There are many causes for this situation. For biomedical engineering circles themselves, one important reason is inadequate understanding of biomedical engineering by society. It is seen as simply a purely technical discipline and as simply an application of various types of modern science and technology in medicine. Actually, the target of service by biomedical engineering is every member of society, so it will inevitably be subject to restriction by the economic bearing capacity of society. If this point is forgotten and we merely pursue S&T advances or merely pursue economic benefits for producing enterprises, the inevitable result will be that biomedical engineering itself will fall into difficult straits. There is only one way to get out of this predicament, which is to change concepts and focus on the social qualities of biomedical engineering. Deal with the requirements of the different levels and different aspects of the medical and health industry and use the economic bearing capacity of society as a prerequisite to develop biomedical engineering. Simply stated, this means developing "economical" biomedical engineering.

Biomedical engineering in China was developed by copying the West. During the early period of formation of the discipline, this type of copying was inevitable. Today, however, with the increasingly acute contradiction between progress in biomedical engineering in the West and its social effects, if we continue to develop by copying the Western biomedical engineering model, the prospects for biomedical engineering in China are dreadful to contemplate. This is because China is a large socialist nation with an underdeveloped economy and relatively backward technology. It has the largest population in the world and expenditures on medical treatment are an extremely heavy social burden. If this already intolerable burden becomes even heavier because of developments in biomedical engineering technology, this type of biomedical engineering will become a negative factor in social development and its

existence will have little value. Thus, developing "economical" biomedical engineering and using biomedical engineering technology and methods to control medical treatment and health care expenditures is an essential route for the future development of biomedical engineering in China. The change in the scholarly ideology of China's biomedical engineering circles over the past 3 years is an excellent starting point for taking this new route.

II. "Economical" Biomedical Engineering

Given China's concrete conditions, there should be two basic requirements for "economical" biomedical engineering. They are having as an objective the urgent medical and health care needs of most people and being based on China's economic and technical possibilities; and promoting improvement of medical levels in China while at the same time helping to control society's medical treatment expenditures.

1. Orient toward the majority

The objective for developing biomedical engineering technology should be the medical and health care needs of the majority of people. China has a huge population that is mostly distributed in rural areas that have medical care and drug shortages. The development of biomedical engineering in China must have this basic fact as its starting point. To give an example, most artificial heart valves in China and foreign countries are mechanical valves and the reason for this is that organic valves in the human body can become calcified and have an average lifespan of about 8 years. Even so, after a mechanical valve is implanted there must be a long period of administering anticoagulant drugs, which usually requires the guidance and supervision of a physician. This might not be much of a problem for developed countries, but it is a much bigger problem for China's vast rural areas. For one thing, it is very hard to guarantee supplies of drugs and medical guidance for rural patients. A second thing is that long-term administration of anticoagulant drugs is a big economic burden. The third is obstruction by the psychological state and living customs of rural patients. Given these problems, as far as China's biomedical engineering circles are concerned, research on the question of anti-calcification in organic materials and the development of new types of organic valves with anti-calcification capabilities should be the primary direction for developing artificial valves in China. Chengdu Science and Technology University and the Chinese Academy of Sciences Fuwai Hospital have done a great deal of work in this area and made gratifying progress.

2. The primary targets of service should be hospitals at the county and ward level

The basic task of biomedical engineering is to provide appropriate technical equipment needed by the medical and health industry on the basis of a deeper understanding of human life activity. This means orienting toward the majority, so the primary task of biomedical engineering in China should be to provide appropriate technical equipment to China's large numbers of medium- sized and small hospitals (at the county and ward level) to raise treatment and prevention levels in our vast rural areas. What our large numbers of basic level hospitals are capable of buying (economic capacity) and using (the required technical forces) is technical equipment that has specific functions, and is economical, practical, simple, and reliable.

It must be stressed that simple and economical do not mean low standards, nor do they mean manufacturing in a rough and slipshod way. Concretely speaking, simple means that we must have a profound understanding of the relevant life phenomena. This means being able to simplify questions and being able to use the smallest number of easily measured parameters to describe changes in states and to design and manufacture technical equipment that has specific functions and that is economical and practical. As for reliability, this is the lifeblood of medical treatment technology and equipment as well as the most deadly weak point in Chinese-made medical treatment technology and equipment at the present time. We can only achieve a basic change in the state of importing large amounts of medical treatment technical equipment when we have solved our reliability problems. At present, Chinese-made electrocardiographs have unstable quality and poor reliability, and a fundamental problem of a low resistance to interference. Moreover, the question of interference is a fundamental topic in medical electronics engineering technology and an important aspect of man-machine boundary engineering technology. Technical advances in this area will lay a technical foundation for resolving the reliability problems of China's medical treatment instruments and equipment.

In summary, developing medical treatment technical equipment with specific functions that is simple, reliable, economical, and practical to meet the needs of medium-sized and small hospitals should be the primary aspect of China's biomedical engineering.

3. "Reliance on our own efforts" is the guiding ideology for developing biomedical engineering in China

There has been considerable enthusiasm for importing and copying following reform and opening up, and the biomedical engineering field is no exception. We feel that opening up to the outside world serves the development of China's economy and that importing and copying serve to strengthen ourselves and rely more on our own efforts. This principle is important for China's biomedical engineering industry because China's national conditions do not permit us to simply copy biomedical engineering from the West. Biomedical engineering in the West is established on a strong basic industry and we cannot create this type of foundation in a short period of time. Beginning with reliance on our own efforts, imports of advanced biomedical engineering technology from foreign countries should: 1) Make careful selections, to select items that conform to China's national conditions, are needed for research work, or are better the more advanced they are, and the goal cannot be the pursuit of short-term economic benefits. 2) On the basis of digesting advanced technology from foreign countries, do our own research work to integrate it with China's existing technical and industrial foundation and convert it into new technology that can be achieved (produced) under China's conditions. In this area, China's development of artificial heart valves where

previously we had none is an example. Chinese-made artificial heart valves (mechanical valves) began with imports and copying. Through joint research by Chinese biomedical engineering workers and medical workers, design improvements were made and they were integrated with plants to form a production capacity on a substantial scale. To date, there have been more than 5,000 instances of the clinical use of Chinese-made mechanical valves. The results of long-term follow-ups of 1,000 cases showed that they attained international levels in early death rates, restoration of heart function, and other areas. China's advances in ultrasonic medical engineering technology are another example in this area and the technical functions of Chinese-made portable B-ultrasound devices are not inferior to those of similar products in foreign countries. These achievements were all made on the basis of "reliance on our own efforts".

4. Grasp trends in modern S&T development, fully foster our comprehensive advantages

We feel that developing "economical" biomedical engineering is compatible and consistent with the inherent high-tech characteristics of the biomedical engineering field. "Poverty methods" do not mean discarding high-tech. Instead, we can develop truly "economical" biomedical engineering only on a foundation of new achievements in modern S&T and through incisive innovation. We have many successful precedents in this area. For example, the Qinghua University Biomedical Engineering Institute applied biodynamics principles and integrated with medical, mechanical, electronic, and modern computer technology to make breakthroughs in the areas of artificial heart valve fluid dynamics functions and fatigue lifespan monitoring technology, and they developed a complete set of monitoring devices at advanced international levels that spurred progress in China's artificial heart valve technology. In another example, the Beijing Emerging Biomedical Engineering Research and Development Center focused on the urgent needs of China's medical circles for long-term dynamic electrocardiograph recording and analysis systems. They made full use of existing computer technology, borrowed from advanced system designs, opened up this weak link in China's precision machine processing, and in just over 1 year's time successfully developed a 24-hour full-information dynamic electrocardiograph recording and analysis system whose technical performance attained international levels of the late 1980's. These achievements are eloquent confirmation that by correctly choosing objectives and being able to establish a correct technology line, it is entirely possible for China's biomedical engineering to move into advanced world ranks despite the relative weakness of China's technical and industrial foundation.

It should be pointed out that the prerequisite for achieving this technical line and fostering comprehensive advantages is close integration of engineering science, medicine, and biology and has clinical practice as its starting point along with close integration of research, design, and industrial departments. This requires organic cooperation of the relevant academic circles and in particular that the relevant departments break down the barriers between departments and industries to engage in multi-industry cooperation. The Biomedical Engineering Society should and can play an even greater role in this area.

III. Conform To and Promote Changes in Medical Models, Open Up a New Route for Developing Biomedical Engineering.

The terrible inflation in medical treatment expenditures that parallels progress in modern medicine creates a huge shock to modern medicine itself and arouses cautious consideration among people. At present, there are two trends that should attract our special attention. One is the change from pure biomedicine to a medical model that integrates biology, psychology, and sociology. The second is the growing attention toward traditional medicine. These two trends are interlinked and all concern changes in medicine itself and changes in medical models. Biomedical engineering serves medicine, so of course it should conform to future changes in medical models. On the one hand, it should create the required technical conditions for this change and thereby promote it, and on the other hand it should also open up other paths for the development of biomedical engineering. For China, the main thing is fully fostering our huge advantages in the area of Chinese medicine and developing biomedical engineering technology with true Chinese characteristics.

Chinese medicine is a magnificent treasure. For several 1,000 years it has played an inestimable role in the prosperity of the Chinese nationality. In the past 40-plus years, Chinese medicine was indispensable to China's ability to make world-acknowledged huge advances in its medical treatment and health care industry using relatively limited investments (compared to Western countries). This should tell us that traditional medicine could play an enormous role in future changes in mankind's medical models. Thus, at the Far East Biomedical Engineering Symposium held in Japan in October 1990, the integration of biomedical engineering with Eastern medicine as represented by Chinese medicine became a major topic of the conference. Those at the conference were unanimous in the view that Eastern biomedical engineering should be characterized by Eastern medicine. Without a doubt, the development of the treasurehouse of Chinese medicine is an important content of China's biomedical engineering.

The integration of engineering science and Chinese medicine is something that occurred during the past 10 years. Our attention to the differences in methodology between Chinese medicine and modern science reinforced multidisciplinary research and gratifying advances have been made in recent years in Chinese medical specialist systems, objectification of tongue diagnosis, Chinese medicine clinical blood rheology, and other areas, and we have formed a specialized staff for Chinese medical engineering. If we can fully foster China's enormous advantages in the area of Chinese pharmacology and reinforce integration of engineering science and Chinese pharmacology, Chinese biomedical engineering will play an inestimable role in promoting changes in future medical models, controlling

medical treatment and health care expenditures, improving the health levels of all of mankind, and other areas, which in turn will make a unique contribution by the Chinese nationality to advances in biomedical engineering S&T as a whole. Moreover, Chinese pharmacology itself will blossom in radiant splendor in the future.

In summary, if the 1980's can be called the decade of China's exploration of biomedical engineering, then the 1990's will be the era of planting ourselves on solid ground, hacking through difficulties, and opening up new routes for future generations. We firmly believe that if we face reality, make concerted efforts, correctly identify directions, and quietly immerse ourselves in hard work, China's biomedical engineering will certainly be able to take its place in world science using its own glorious characteristics.

Strategy To Develop S&T in Pharmaceutical Industry

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[Article by Ren Dequan [0117 1795 2938]: "Some Views on S&T Development Strategies in China's Pharmaceutical Industry"]

[Text]

I. The Current Situation of S&T Forces in the Pharmaceutical Industry of China and Foreign Countries

The technical forces of the pharmaceutical industry of each country internationally are divided into four categories and four levels. Category 1 is large corporations with systematic formulation capabilities that continually develop new special-purpose drugs and guide the international drug market and which have high prestige in the international drug industry. Over ten countries including the United States, Japan, England, Germany, France, Switzerland, Italy, and others belong to this category. The new drugs they study, formulate, and place on the market account for 95 percent of the world total and the yearly output value of their pharmaceutical industries accounts for about 85 percent of the world total value. Category 2 includes those with less than powerful new drug formulation and development capabilities but that do have a substantial ability to absorb and copy technology and a scale of stock drug production. There are over 10 countries in the world which belong to this category, including the Soviet Union, India, Hungary, Portugal, Spain, Brazil, South Korea, and others. Category 3 includes those with a weak stock drug production technology capabilities but which do have definite strengths in preparation technology and which import stock drugs and process them into various types of preparations. There are quite a few countries and regions in this category, including economically developed countries and regions like Australia, Austria, Singapore, and others as well as a considerable number of developing nations and regions. The pharmaceutical industry technology situation in China's Taiwan region also belongs to this category. Category 4 includes those which have only a weak preparation processing technology and which directly import various types of finished drug preparations. The situation in China's pharmaceutical industry 40 years ago was in this category. At that time, we have an extremely weak technical capacity for producing stock drugs or preparations and basically relied on imports for our chemical drugs.

China has gradually established a pharmaceutical industry S&T staff over the past 40 years. We have also tracked S&T achievements in the international pharmaceutical industry and studied and placed into production over 1,300 types of new stock drugs and 4,000-plus types of preparations. We now produce our own series of products in 24 main categories ranging from analgesic- antipyretics, antibiotics, vitamins, endemic disease drugs, contraceptives, hormonal drugs, cardiocerebrovascular drugs, antineoplastic, diagnosis drugs and so on. We have developed international vanguard unique technical lines in production technology for vitamin C, chloramphenicol, streptomycin, and the recent naproxen, norfloxacin, and other stock drugs. A national pharmaceutical industry system composed of an huge army of 1 million with a full complement of categories on a substantial scale stands lofty and firm. On the foundation of satisfying the medical treatment and health care needs of people in China, large amounts of stock drugs have entered international markets beginning in the 1980's. Now, we usually have the S&T capability of successfully developing and organizing the production of new chemical compound drugs that come on the market in foreign countries within 3 to 5 years. It can be said that after nearly 40 years of efforts, overall S&T forces in China's pharmaceutical industry have moved into the lead among the second level of the world.

II. Basic Strategic Tasks in Pharmaceutical Industry S&T Work

Serving the achievement of medical treatment, health care, recovery, and birth control for all the people of China at a relatively prosperous level and serving the improvement of the international competitiveness of China's pharmaceutical industry are the two basic strategic tasks starting now for China's pharmaceutical S&T work.

By the end of this century, people's living standards should reach the relatively prosperous level. Starting from this, there are requirements in at least four areas that face pharmaceutical S&T work: 1) Continued R&D on new replacement drugs and various types of new preparations, improvement of the quality of drugs that people use. 2) Based on our economic development situation and living and working conditions, changing the structure of disease occurrence, reinforcing R&D on the corresponding categories and series of new products. 3) Making major efforts to open up new realms of products and new types of products used for prevention, health care, and recovery. 4) Striving to develop new techniques and technologies, improve productivity, and reduce drug costs. For the past 40 years, we have consistently made satisfying the needs of people in China the basic strategic task in pharmaceutical S&T work and in the future we should still make satisfying the

medical treatment and health care needs at relatively prosperous living standards of our people the number one task in pharmaceutical S&T work.

Based on the requirement of central authorities for an economic doubling [doubling the value of industrial and agricultural output], a specific development pace should be maintained in the pharmaceutical industry. The existing economic scale of China's pharmaceutical industry is based on both the domestic and international markets. On the basis of satisfying domestic demand, we can also export one-fourth of our total output of stock drugs each year and earn foreign exchange directly for the state. Redoubling economic development of drugs will require major efforts to open up international markets, especially high-level markets. The prices for China's export drugs average about $20 per kilogram, which is only one-twentieth the average value for the world drug trade, so we must try to improve export results and change this situation. Moreover, our domestic market is facing challenges from foreign investment enterprises and imported drugs. Thus, using S&T to increase our international competitiveness is very important. Projections in foreign countries indicate that the volume of drug sales in the world will double over the next 10 years and reach $370 billion. There are opportunities here as well as even greater competition. Pharmaceutical S&T workers are duty-bound to take on improving the international competitiveness of industry and enterprises as a long-term basic strategic task of the future.

These two main strategic tasks are interrelated. From the perspective of the industrial development process, only on the foundation of the first task of satisfying domestic demand can we be able to consider the second task of taking a major step toward the world. From the perspective of the existing situation and the requirements of S&T force levels, however, only from the heights of the second task of orienting toward international markets to consider future pharmaceutical S&T work can we sustain the main force in the domestic market in a situation of opening up and truly take on the first task.

III. New Characteristics of Competition Centered on S&T in the International Pharmaceutical Industry

The value of output of the world's pharmaceutical industry increased by an average of 10 percent a year during the 1980's and the volume of international trade reached $100 billion, so the pharmaceutical industry is one of the high-tech industries with the greatest development prospects. The profit rates of the world's top 10 pharmaceutical enterprises are all about 30 percent. Since scientific research and development expenditures, which account for 10 to 16 percent of their total volume of sales, are included in costs, their actual profits from production and management are even higher. The broad prospects and high profits of the pharmaceutical industry have attracted many international corporations to engage in fierce competition in the market. The core of the competition is S&T competition which is reflected in a concentrated way in four areas.

1. Relying on research to create new drugs, strengthening patent protection measures, and fighting for a monopoly status in international markets.

Internationally, it takes about 10 years to study and develop a new drug and costs about $250 million. There has been no decrease, however, in the enthusiasm of all large corporations for studying and developing new drugs. In 1990, R&D expenditures by drug development companies in the United States accounted for 16.8 percent of their total volume of sales, the highest for all industrial sectors, and reached $8.2 billion, two times the 1985 figure. R&D expenditures in England's largest drug enterprise, Glaxo Corporation, were 24 percent higher in 1990 than in 1989, reaching $800 million. This background of high investments is monopolistic under patent protection for creating new drugs and this monopolistic character creates high profits. All of the 50 top-selling drugs in the world in 1989 were new patented drugs developed by large corporations. They included 16 varieties at more than $500 million. Lenitidin from England's Glaxo Corporation had the highest volume of sales at $2.37 billion. In comparison, China exports over 20,000 tons of stock drugs each year, higher than the annual output in England, but all of them are non-patented imitations and we earned only about $500 million in foreign exchange. The economic benefits of imitation drugs cannot be compared to those of newly developed drugs. Not long ago, Japan extended the time period for patents from 20 years to 25 years. The EEC has also suggested extending patents for new drugs by 10 years. These stronger measures to protect the unique status of new drugs have further stimulated large enterprises to make developing new drugs the first battlefield in their fierce rivalry. There were mergers between the Shike (0670 0344) Corporation in the United States and England's Piqiemu (4122 0434 1191) Corporation and between the Squibb Corporation and Bristle-Meyer Corporation in the United States, which were formerly among the top 10 in the world. The international assessment is that this sort of merger is not the same as the annexation of competing businesses but is instead the result of intense S&T competition. Thus, to deal with this type of competition, this is integration activity to obtain an innovation force (over $500 million annually in investments and a scientific research staff of more than 3,000 people) that can fight against other large corporations.

2. Relying on modern engineering technology, achieving scale production of staple product varieties, and fighting for a leading status in this realm.

Non-patented staple product varieties depend entirely on price competition. Unit profits are not high but markets are more stable and the total volumes are substantial. Foreign countries have used modern engineering technology as a foundation in focusing on continuity, automation, and complete sets of scale production technology in developing these product varieties to achieve high efficiency, low consumption, and superior quality intensive large-scale production, gain overall advantages, and maintain a leading status. The Monsanto Corporation in the United States, for example, produces 10,000 tons of

aspirin a year, one-fourth of the world total output. Malinkrodt Corporation produces 8,000 tons of acetaminophen each year, one half of total world output. Switzerland's Roche Corporation has three plants in Scotland, Federal Germany, and the United States that produce nearly 40,000 tons of vitamin C each year, which is equivalent to the world total demand. Brufen is a patented product of England's Puci (5543 5412) Corporation. After the patent expired in the mid-1980's, the price dropped and there was a large increase in amounts used. Puci Corporation seized the opportunity to use the engineering technology it had developed to achieve scale production and placed two enterprises with yearly output of more than 2,000 tons into operation, which reduced the selling price from $25 to $15 per kilogram. Enterprises in Italy, Holland, and Spain which had production scales under 500 tons announced that they were closing and the Puci Corporation's leading status for brufen was maintained.

3. Relying on preparation technology, developing name brand drugs, fighting for a leading market status.

After the concept of bioeffectivity was proposed during the 1960's, the field of biopharmaceutics emerged and everyone gained a new understanding of the importance of preparations. Several types of quick-release, slow-release, controlled-release, and targeted preparations as well as mucous membrane and skin penetrating absorption and other types of new preparations appeared. Preparations have become a comprehensive discipline. Unique preparation technology for non-patented stock drugs in conjunction with brand names have become famous brand preparations and drugs that also have monopolistic characteristics in the market. Their value can be 10 times higher than stock drugs. An example is the famous drug "Ledewei" from Holland's (Lede) Corporation. It is made from the stock drug bismuth subnitrate that is imported from China using a special technology to powder and mix it to make granules that are used to make a preparation that has significantly improved curative effects and a value nearly 10 times higher that is sold throughout the world. Now, pharmaceutical companies in the developed countries are trying to import stock drugs for non-patented medications and focusing their scientific research and production on preparations. After the United States balanced its imports and exports of stock drugs in 1989, its net exports totalled $600 million. After the balance of imports and exports of preparations, its net exports totalled $9.75 billion. Net imports of stock drugs increased to $1 billion in 1990 but net exports of preparations reached $11.7 billion. Of the series of compound preparations of acetaminophen from the Johnson & Johnson Corporation in the United States, 10 are among the 100 most popular drugs in the United States, but all of the stock drugs for the acetaminophen were imported.

4. Relying on modern biotechnology, opening up new technical foundations and product series, fighting for a long-term strategic advantage status.

Biotechnology is a hot point in the modern new technological revolution, while 70 percent of the international research work falls within the scope of drugs. All of the industrial applications of recombinant DNA and hybridoma technology started from drugs. The first genetic engineering product "human insulin" formally appeared on the market in the United States in 1982 and four of the 10-plus genetic engineering drugs that have appeared on the market since have yearly sales volumes exceeding $200 million. Modern biotechnology has opened up new arenas for source polypeptides and protein drugs in humans. At the same time, biotechnology has permeated all fields of traditional medicine. It covers areas ranging from bioconversion methods for cell fusion and breeding of antibiotics and amino acids, genetically engineered microbes, and chemically synthesized drugs to monoclonal antibody targeted preparations, and so on. Some have said that drug production technology is now changing from having a foundation in chemistry to a foundation that integrates biology and chemistry. Not long ago, Lilly Corporation in the United States proposed that an even greater application for biotechnology in pharmaceutics was a revolution in new drug research and selection methods, meaning the substitution of genetically engineered receptor experiments for animal experiments. All of these things indicate that a strategic transformation is now occurring in the technical foundation of the pharmaceutical industry. Many large corporations in the world are investing huge sums on products centered on modern biotechnology, opening technical structures, and orienting toward intense competition in the 21st Century.

IV. Strategic Objectives for the New Stage of S&T Development in the Pharmaceutical Industry

For the past 40 years, we have been in a development phase of having as our primary task achieving basic self-sufficiency in domestic drug supplies, establishing and expanding our pharmaceutical industry production and technology system as our primary objective, and tracking new achievements in pharmaceutical products in foreign countries as our primary content. During this historical stage, we basically completed the task of building China's imitation-type drug R&D system and our overall S&T strengths attained a second-level status in the world.

Now, faced with intense S&T competition in the world pharmaceutical industry, we are now historically in a new development phase. There are two basic tasks involved in pharmaceutical S&T work during this new stage: S&T development will gradually shift toward a foundation of tracking and absorbing new international pharmaceutical R&D methods and technologies and have as its primary content the continual promotion of China's own new patented products and new technologies. The strategic objective of S&T construction should be striving to establish a pharmaceutical industry S&T R&D system with Chinese characteristics that is centered on taking the initiative in S&T research, attaining a first-level status in the world in S&T strengths, and making pharmaceutical S&T China's strong point.

V. Strategic Focus for Pharmaceutical S&T Development

To achieve our overall strategic goals for pharmaceutical industry S&T development in the new stage, we must not waste the opportunity to make significant advances in the four areas of drug innovation technology, preparation technology, large-scale production and engineering technology, and modern biotechnology. This is the locus of our strategic S&T focus that will determine the success or failure of China's pharmaceutical industry.

1. Make basic system construction the core, achieve a strategic transition from "imitation" to "innovation" in drug research.

Since the founding of China, we have developed over 100 new drugs but their quality was not high and only a few of the product varieties gained a foothold in our domestic market and became common treatment drugs. Moreover, the experimental data and research information on these product varieties could not be internationally recognized and accepted. Summarizing our experiences, the main thing is that we lacked an integral formulation R&D system and standardized systematic research. Our scattered and isolated formulation activities made it hard to make high-level achievements. In this regard, our strategic transition from "imitation" to "innovation" cannot flow with circumstances. The key is in establishing a matching drug innovation R&D system that conforms to the requirements of the era and an integral foundation for innovative research. This matching system and integral foundation should be composed of three main areas. They are: 1) an innovative research technology system that includes a research scope centered on technologies for selecting various types of drugs; 2) an innovative research base area system including new material preparation base areas, various types of drug selection base areas, toxicology centers, preparation research base areas, drug substitution base areas, production and development base areas, and so on; 3) an innovative research organization system with several innovative research staffs composed of a set of disciplines including synthesis, analysis, pharmacology, toxicology, drug eras, standards, preparations, technology, engineering, and so on as well as a full set of organizational mechanisms for orderly operation and cooperative battles. Over the next 10 years, we should establish a matching innovative research system that basically conforms to GLP requirements in these three areas and gradually shift the primary activities in China's drug scientific research into this system and foundation.

2. Promote three types of integration, develop unique base areas, make comprehensive breakthroughs in developing preparations, move from weakness to strength in preparation technology.

At present, China's exports of preparations only account for 7 percent of our total exports, and there are also phenomena of exporting stock drugs while having to import preparations. Backward preparation technology is one major reason for this. Preparation enterprises have made considerable progress in the production plant buildings and equipment as well as packaging materials and technology over the past 10 years, scientific research units have made outstanding achievements in attacking key technical problems focused on new supplements and new agents, the concept of bioactivity of preparations has been popularized in the quality inspection area, and strippability standards and so on have received wide attention, but there has been no fundamental change in the situation of experience still being the main factor in the production process for many preparations, singularity of product agents, poor bioactivity, and so on. For this reason, we should use this foundation in a major effort to promote the integration of scientific research units with production enterprises, promote the development of integrating new attacks on key technical problems with new series of products, and promote the integration of biopharmaceutics with physical pharmaceutics and preparation engineering. While implementing GMP in preparation plants, we should also be concerned with integration with scientific research, developing new preparations, and raising product levels. On the basis of continually attacking new technologies, scientific research units should be concerned with applying technical reserves and assist enterprises conducting GMP upgrading in developing new series of products that are internationally competitive. With a prerequisite of continuing to focus on biopharmaceutics, enterprises and scientific research units should focus on physical pharmaceutics and preparation engineering, establish bioactivity standards and improve bioactivity, and combine improvement and enrichment of agents with efforts to quantify and optimize technical processes. They should also focus on reinforcing existing specialized preparation research units and turn them into research base areas where each has its special advantages and complements the others. Encourage and support several key preparation plants in establishing applications development staffs, developing their own technologies and products, and creating well-known series of product varieties that cover a broad area of the market. In this way, each will have their own slant and work comprehensively and within a relatively short period of time there could be substantial improvements in overall preparation technology levels, which would gradually make them competitive internationally.

3. Make major efforts to improve industrial production technology levels, move from backward to advanced in pharmaceutical engineering technology.

China ranks among the world's leaders in yearly output of drugs and we are a large drug producing nation. Our enterprise structure, however, is dominated by small-scale production. There is very little research on engineering technology questions in this type of situation. For stock drugs, production costs and benefits are the key to competition. The task of so-called engineering technology research is, with a prerequisite of ensuring quality, to increase productivity and increase economic benefits. We should focus on reform of technical lines and strengthen chemical engineering research for production and engineering technology. With a prerequisite of making major efforts to undertake unit operations research, we should also carry out technical development and equipment

updating. It should be noted that a scale economy is not simply a question of centralized deployments. Even more important is that it is established on a foundation of modern engineering technology and becomes an intensive and completely new production pattern. Thus, for staple product varieties that have development prospects, we should start now in selecting certain key product varieties, integrate with future capital construction and technical upgrading plans, carry out comprehensive R&D on engineering technology in advance regarding production processes, unit operations, key equipment, design and operating parameters, comprehensive energy resource utilization, and so on, and use this as a foundation for computer on-line control applications to provide a design and operating technology foundation for projects and make continual improvements in production engineering technology levels for new projects. For products with a large market coverage rate and limited output, improvements in their production patterns can begin with key aspects that are highly generalistic and have prominent problems, unit operations such as fermentation, filtering, extraction, crystallization, drying, and so on in conjunction with computer on-line control applications to do research, make some breakthroughs, and extend them. This could gradually raise engineering technology levels in the pharmaceutical industry.

4. Work backwards moving up, focus on industrial applications of biotechnology, achieve a strategic shift in the pharmaceutical technology foundation structure.

Biotechnology is an important aspect of high technology and has received a high degree of attention from the state. Basic research on it has already gotten underway and definite achievements have been made. On this foundation, the pharmaceutical industry should look toward industrialization of biotechnology and focus on understanding and developing key mid-stream and downstream technologies like cultured expression technology, separation media and purification technology, and so on. At the same time, it should actively participate in R&D on upstream technology, integrate upstream achievements with attacks on key problems and imports, achieve industrialized commodity production, and gradually establish the new branches of modern polypeptide and protein drugs in the pharmaceutical industry. We can begin now by choosing to industrialize the production of monoclonal antibody diagnosis drugs. At the same time, we should make major efforts to apply genetic engineering, cellular engineering, enzyme engineering, fermentation engineering, and other modern biotechnologies in antibiotics, amino acids, and other traditional medicine biotechnology products to upgrade traditional technology. For several chemically synthesized drugs, actively apply bioconversion methods and other new technologies to replace complex chemical reactions. In summary, we should strive to make modern biotechnology permeate every realm of the pharmaceutical industry.

The medicine of the Chinese nationality held a leading status in the world for a long period of history more than 300 years ago and we are still internationally acknowledged as a major traditional drug country. However, during the process of developing chemical drugs over the past 300 years, we have been backward for a long period and lag far behind advanced levels. However, after 40 years of efforts, we have made great progress in moving from reliance on imports to exporting large amounts. Looking toward the future, we should have even more determination to struggle hard to move China's modern pharmaceutical industry into the first ranks of the world, make it a source of power for our nationality, increase our national glory, and bring prosperity to mankind.

The Studies About Characteristics of External Air-Lift Reactor and Treatment of Rice Fermented Waste Liquid by External Air-Lift Reactor

40091010C Beijing SHENGWU GONGCHENG XUEBAO [CHINESE JOURNAL OF BIOTECHNOLOGY] in Chinese Vol 7 No 4, Nov 91 pp 359-364

[English abstract of article by Xia Lincong [1115 2651 5115] and Gao Kongrong [7559 1313 2837] of the Institute of Biological Engineering, South China University of Technology, Guangzhou]

[Text] This paper studies the characteristics of selected reactors, that is gas hold-up, mixed time, volumetric oxygen transfer coefficient, etc. These experiments were carried out in bubble column reactor or external air-lift reactor with water-air system. The experimental characteristics equations of bubble column reactor and external air-lift reactor were gained through the experiments and regression of the experimental data. Consequently, the external air-lift reactor that had better characteristics was chosen to be used for treatment of rice fermented waste liquid and produced BN99 fungi. After 16h to 20h fermentation, the results are :1. COD value of waste liquid reduced 60-70 percent, pH value increased from 5.2 to 6.5, coarse protein content of BN99 reached 38.88 percent. The solid and liquid were easy to be separated. So the external air-lift reactor is a good characteristics reactor, especially good for waste liquid treatment and fungi fermentation.

Chemical Synthesis and Cloning of the Signal Peptide Gene of *Escherichia coli* ST-II

40091010E Beijing SHENGWU GONGCHENG XUEBAO [CHINESE JOURNAL OF BIOTECHNOLOGY] in Chinese Vol 7 No 4, Nov 91 pp 378-381

[English abstract of article by Jing Guozhong [7234 0948 1813], Zhang Guangfa [1728 1639 3127], et al. of the Institute of Biophysics, Academia Sinica, Beijing]

[Text] The signal peptide gene of heat-stable enterotoxin II of *E. coli* was chemically synthesized according to codon usage in *E. coli*. A signal peptide gene cartridge plasmid pST-II was constructed by inserting the signal peptide gene into BamH I/Pvu II sites of pBR322. The gene block can easily be excised and transferred to other genetic systems

for construction of secretion expression vector by digestion with BamH I and Xho I/Kpn I. The GCGC sequence at 3'-end of ST-II signal peptide gene provided Hha I/Hinp I cut sites which should be convenient for inserting target gene in frame.

Site-Directed Mutagenesis of Lys5 and Arg9 Residues in the Arm of EcoRI Endonuclease

40091010G Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 23 No 6, Nov 91 pp 494-499

[English abstract of article by Yang Xiangjiao [2799 7449 1293], Chen Changqing [7115 1603 1987], and Wang Debao [3769 1795 1405] of the Shanghai Institute of Biochemistry, Academia Sinica, 200031, and Yang Shengli [2799 0524 0448] of the Shanghai Center of Biotechnology, Academia Sinica, 200233]

[Text] Two site-directed mutations were introduced into the arm of EcoRI endonuclease by deletion of Lys4Lys5 with PCR and replacing Arg9 with Asn9, resulting in EcoRI (ΔLys4Lys5) and EcoRI (Asn9). Assays of SDS-PAGE and cleavage activity showed that the specific activity of EcoRI (ΔLys4Lys5) approximated that of the native enzyme, but the specific activity of EcoRI (Asn9) was about three times lower than that of the native EcoRI. Relationships of K_a-[NaCl] for them, determined via gel retardation, revealed that the mutations had no effect on the ionic interaction between EcoRI and its cognate DNA sequence.

RNA Synthesis via Transcription in Vitro by T7-RNA Polymerase

40091010H Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 23 No 6, Nov 91 pp 500-506

[English abstract of article by Liu Jianhua [0491 1696 5478] and Wang Debao [3769 1795 1405] of the Shanghai Institute of Biochemistry, Academia Sinica, 200031]

[Text] Yeast alanine tRNA and its 5'-half molecule (1-35 nucleotides) and 3'-half molecule (37-75 nucleotides) without the modified nucleotides were obtained via the transcription by T7-RNA polymerase in vitro of chemically synthesized DNAs coding for yeast alanine tRNA and its two half molecules. The amounts of the RNAs obtained by this method were 20-80 times of the DNA templates, which suggests that this should be a very useful method in RNA research.

Temperature-Inducing High Level Expression of Porcine Growth Hormone in *Escherichia coli*

40091010B Beijing SHENGWU GONGCHENG XUEBAO [CHINESE JOURNAL OF BIOTECHNOLOGY] in Chinese Vol 7 No 4, Nov 91 pp 307-311

[English abstract of article by Xu Xuping [0151 2485 1627] and Qi Shunzhang [7871 7311 4545] of the Laboratory of Animal Biochemistry, Beijing Agricultural University, Beijing]

[Text] Temperature inducible *E. coli* expression vectors of pGH gene were constructed. After the transformation of *E. coli* N4830 with them and induction by temperature shift, high level expression was achieved. The expressed pGH, as verified by migration rate in SDS-PAGE and Western blot, accumulated up to about 30 percent of the total bacterial cellular proteins as estimated by Shimadzu CS-910 scanning of the SDS-PAGE gel stained by Coomassie brilliant blue R250.

Construction of Recipient Strains for Cloning of Yeast Glucose Amylase Gene

40091010D Beijing SHENGWU GONGCHENG XUEBAO [CHINESE JOURNAL OF BIOTECHNOLOGY] in Chinese Vol 7 No 4, Nov 91 pp 372-375

[English abstract of article by Mao Xiaohong [3029 1420 3163] and Cai Jinke [5591 6855 4430] of the Institute of Microbiology, Academia Sinica, Beijing]

[Text] The recipient strains for cloning of yeast glucose amylase gene have been constructed by means of micromanipulation technique. One of the segregants with auxotrophic marker (trp1), SD-4-23b (α trp1 arg4 STA2 inh°), was obtained from the cross between *S. cerevisiae* DP-1 (his1 trp1 sta° INH1) and *S. diastaticus* 5206-1B (a arg4 STA2 inh°). Then the segregant was hybridized with *S. cerevisiae* YIYD (a leu2-3, 112 his4 lys7 sta° inh°). Eleven recipient strains (trp1 sta° inh°) derived from the latter cross are suitable for the transformation of *E. coli*-yeast shuttle plasmid pCN60 (TRP1) and cloning of glucose amylase gene. Some of the segregants with different auxotrophic markers and STA2 gene which were capable of fermenting starch more rapidly were also obtained.

Chemical Synthesis, Cloning and Expression of Human Epidermal Growth Factor Gene in Yeast *Saccharomyces cerevisiae*

40091010A Beijing SHENGWU GONGCHENG XUEBAO [CHINESE JOURNAL OF BIOTECHNOLOGY] in Chinese Vol 7 No 4, Nov 91 pp 300-306

[English abstract of article by Yuan Hanying [5913 3352 5391], Min Yongjie [7036 3057 3381], et al. of the Institute of Genetics, Fudan University, Shanghai, and Lu Huimei [0712 1979 2734], Zhang Chenggui [1728 2110 3932], and Hu Qian [5170 0241] of the Department of Biochemistry, Nanjing University, Nanjing]

[Text] A gene coding for human epidermal growth factor (hEGF) has been chemically synthesized by solid-phase phosphoramidite method. The 173 base-pair synthetic DNA duplex consists of structural gene encoding hEGF, a stop codon TGA at 3' end and some convenient restriction sites at both ends of the gene. The synthesis of the gene involved enzymatic joining of eight oligonucleotides to form DNA duplex which was cloned into vector M13mp18. The recombinant colonies were identified by dot hybridization and restriction enzyme digestion. Its accuracy was confirmed by DNA sequence analysis. The hEGF DNA was inserted in yeast secretion vector YFD59.

The resulted expression plasmid YFD104 was introduced into yeast *Saccharomyces cerevisiae*. The binding assay showed that the yeast transformants could express and secrete hEGF.

The Selection and Breeding for High Production Bacterial Strains of Thermostable FD DNA Polymerase by Mutagenesis

40091010F Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 30 No 4, Dec 91 pp 399-404

[English abstract of article by Yang Shuqing [2799 2885 7230], Mao Yumin [3029 5940 3046], et al. of the Institute of Genetics]

[Text] Thermus sp. FD3009 was treated with nitrosoquanidine, mitomycin C, and UV light and a resistant mutant strain FD20.1 was obtained. FD20.1 was not different from FD3009 with respect to the temperature and pH range of growth, but differed in being paler in colour. The DNA polymerase production of FD20.1 was 38.7 percent higher than that of FD3009. FD20.1 could easily be induced to show high resistance toward mitomycin C, but the resistance declined gradually on subculturing. The high resistance toward mitomycin C seems also to be related to high productivity of DNA polymerase.

Developing Breeding Technology Using Biotechnology

92FE0029E Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 5, Sep 91 pp 40-42

[Article by Tong Dijuan [4547 3321 1227] and Wang Xingguo [3769 5281 0948] of the Hebei Provincial Academy of Agricultural Sciences: "The Scholarly Relay Mechanisms of Biotechnology Research and Development"]

[Text] [Abstract]

This article describes the primary achievements of China's basic and methodology research in biotechnology, analyzes our advantages in the field of agricultural breeding, and on this basis proposes the establishment of scholarly relay mechanisms from the central government to local areas and among basic research, improvement of varieties, biotechnology, and crop breeding, and opening up new routes for breeding.

The wheat breeding expert and Nobel Prize winner Norman Brown has stated that "in the future, new technologies like tissue culturing and genetic engineering may give us huge rewards and bounties. Still, we should not neglect research in the rather conventional field of plant breeding. The reason is that it is the main front in the modern grain battlefield." Moreover, statistics show that in the last half century, 50 to 60 percent of increases in output of primary agricultural crops came from genetic improvements. Thus, in plan management, direction by plans is used to foster advantages in the two areas of biotechnology and improvement of varieties, achieve organic integration, and compensate with advantages. Establishing scholarly relay mechanisms and opening up new routes for breeding will play an important role in technical upgrading of China's agriculture.

I. Cellular and Molecular Operations Will Create New Changes in Breeding Methods

Breakthroughs in biotechnology theories and methods have provided foundations and routes for achieving molecular breeding and the methods of molecular breeding are becoming increasingly perfected. The seedling immersion method, glume injection method, stigma injection method, and grain injection method inject foreign DNA into receptor cells. Back in the 1970's, Zhou Guangyu [0719 0342 1342] and others cooperated with the Jiangsu Academy of Agricultural Sciences inject donor DNA segment into ovary, bred the withering-resistant yellow-tolerant new cotton variety strain 3118, and established China's first molecular breeding support and experiment station.

Since the 1980's, there have been even more rapid developments in genetic operations technology at different levels of cell structure or at the molecular level. Gratifying achievements have been made in plant protoplast cultivation and fusion and starting to test techniques for the guided injection of foreign genes. Agrobacteria are used as a carrier to insert recombinant DNA into receptors to obtain tobacco plants that are immune to TWV disease. Using chemistry and physics methods to obtain the objective of cell hybridization has also aroused universal attention. There have been successful reports of the use of the PEG method, hemolytic lecithin method, calcium ion method, and oligosaccharide method in protoplast fusion to obtain hybrid plants with common tobacco and Huanghua ["yellow flower"] tobacco interspecies somatic cells. Gene gun injection technology has been used for directly introducing foreign DNA into protoplasts, single cells, or small pieces of tissue with a very high conversion efficiency and results that would be impossible to obtain with other methods were achieved in soybeans and corn. Electrically stimulated fusion technology is a new achievement that attracted the most attention during the 1980's and has a fusion efficiency that is more than 100 times higher than chemical methods. It has been widely adopted in breeding circles. Laser micrometer technology has given cell fusion greater selectivity and a success rate of more than 40 percent. China successfully developed a type of scanning tunneling microscope (STM) based on quantum tunneling effects that has provided a powerful measure for ultramicro cellular operations and molecular operations.

II. Local Advantages in Using Biotechnology for Improvement of Varieties

Province-level breeding units are the basic force in the improvement of crop varieties as well as a powerful local army in China's bioengineering applications research. The application of modern biotechnology to improve crop varieties has prominent local characteristics.

A. Ecologically unique gene library

China has a vast territory and a history of agricultural civilization extending for several thousand years. All types of local crop varieties or unique species resources with different ecological characteristics have evolved that provide a rich gene library contents for the improvement of crop varieties. Crop variety annals from the Hebei Provincial Academy of Agricultural Sciences alone list 19,170 records of various types of local crop variety resources, including 1,706 records for wheat. Character identification allows them to be divided into more than 40 genotypes. Analysis by the Hebei Agricultural University Species Research Center of 2,300 materials identified 746 materials with uniquely superior single-item character indicators and they have become valuable species resources for character breeding in Hebei Province.

B. We have a definite foundation in laboratories, experimental facilities, and experimental technology

After making breakthroughs in plant tissue culturing theory and technology in the 1970's, the Chinese Academy of Sciences [CAS] quickly extended them to province-level breeding units. Under the guidance of relevant research institutes of the CAS, the Hebei Academy of Agricultural Sciences established a Biotechnology Laboratory and undertook the corresponding applications research. The research produced four achievements, a high recovery rate (12.19 percent) culture base, increased culture temperature (29 to 30°C), optimum agar concentration (700 mg/l), and selection of several parents with induced recovery rates that held stable at more than 6 percent, and they cultured the new flower-bred wheat variety "Hua 78-555". On this foundation, they cooperated with the CAS Genetics Institute and extended 24 wheat varieties into production, all of which induced protoplast regeneration plants, a major step toward the application stage for molecular breeding. All provinces are extremely interested in applying biotechnology to improve crop varieties. The government of Hebei Province issued a special grant to establish the Hebei Provincial Academy of Agricultural Sciences Biotechnology Laboratory to supplement its Physiology Laboratory. The Beijing Municipality Academy of Agricultural Sciences established a Biotechnology Research Center, the Jiangsu Academy of Agricultural Sciences established an Agricultural Biology, Genetics, and Physiology Institute, the Shanxi Academy of Agricultural Sciences established a Genetics and Breeding Institute, and the academies of agricultural sciences in Jilin, Zhejiang, Shanghai, and other provinces and municipalities established breeding-related biotechnology laboratories which gave them definite strengths.

C. A breeding staff with a definite capacity for digesting biotechnology has been formed

Biotechnology research and achievements must eventually be used in breeding, and breeding must rely on biotechnology for additional upgrading to make continual improvements. Having a high-level breeding staff undoubtedly is an important intellectual foundation for assuming responsibility for digesting biotechnology, optimizing the integration of central authorities and local organs, and fostering the advantages of each to make good attacks on key problems. According to statistics from the Hebei Academy of Agricultural Sciences alone, 86 of its 218 topic directors were involved in plant breeding, accounting for 39.4 percent, and they included 80 high-level research personnel at the assistant researcher level and higher, so they concentrated 41 percent of the high-level skilled personnel of the academy. These personnel were used as a core for establishing a pyramid-shaped personnel structure with an overall 1:2:4 ratio of high, middle, and low levels. They are now conducting planned knowledge training to absorb and apply biotechnology and they are working on establishing cooperative relationships with relevant units of central organs.

D. Readjust research directions, face the challenge of biotechnology

Biotechnology research achievements provide extremely good opportunities for breeders to breed ideal new crop varieties. Breeders have already shifted their goal toward integration of biotechnology with conventional breeding. The Jiangsu Academy of Agricultural Sciences has made biotechnology a goal of its main attack and is applying high technology to upgrade traditional agriculture, with excellent results. Starting during the Sixth 5-Year Plan, they engaged in international exchanges and trained high-level biotechnology personnel that made full preparations for attacks on key high-tech problems during the Seventh 5-Year Plan. Because they were farsighted, began early, and achieved results, they were given most of the biotechnology topics from the state and Ministry of Agriculture during the Seventh 5-Year Plan and made gratifying achievements.

III. Establish China's Biotechnology Development Mechanisms, Raise the Quality of Improved Crop Varieties

Central and local research organs all have advantages in basic research and applied research, and all of them can carry things to the end, so to foster the potential of each we must reinforce four mechanisms.

A. Scholarly relay mechanisms

Obviously, the CAS and key institutions of higher education are the main forces in China's biotechnology theory and methods research. Province-level breeding units have the capacity for continuing on with, digesting, and absorbing research achievements and they have become the main force in applying high-tech breeding. These two aspects are like a relay race, with the top linked to the bottom, cooperating in research, and separately attacking key problems. Province-level breeders convert biotechnology research achievements into breeding practice to form new breeding technology systems.

B. Organizational integration mechanisms

The CAS and key institutions of higher education are China's biotechnology research centers while province-level breeding units are local breeding centers. The conversion and radiation of biotechnology achievements, personnel training, separation and extraction of target genes, cultivation, identification, and selection of conversion gene plants, variety (strain) identification and extension, and so on all require integrated activities by both areas. At present, integrated arrangements are still limited and no close integration systems have taken shape. To establish a highly effective integration system, we must establish vertical and horizontal integration from the center to local areas, divided by discipline and divided by crops in an integrated network with a division of labor and bias for each part. S&T administration departments at all levels should strengthen coordination of management, foster the guiding role of plans, expenditures, policies, systems, and other management measures, integrate basic research and applied research, organize every aspect, and accelerate the pace of attacks on key problems.

C. Agricultural enterprise investment mechanisms

Investments to develop biotechnology by agricultural enterprises or seed companies are the key to success in accelerating the improvement of crop varieties. Looking at the competitive momentum of the international biotechnology market, there are 350 seed companies or multinational seed companies in the world that have entered the field of biotechnology development in an attempt to be the first to develop new products and take over the international market. An example is England's Agricultural Genetics Corporation (AGC) which has used £17 million of its registered capital to subsidize England's Agriculture and Food Research Commission (AFRC) in developing plant biotechnology achievements. The Kodak Corporation in the United States provided development capital to Cornell University to study wood fungi protoplast fusion production of seed protection agents and achieved a very high market sales volume on a world scale. Investments in biotechnology by 10 large enterprises in West Germany are more than four times greater than investments by the government. Enterprise investments have accelerated the transfer of biotechnology achievements and greatly stimulated biotechnology research.

From the beginning, China's biotechnology research was extremely concerned about integration with applications. Statistics indicate that applied genetic engineering has selectively bred over 300 new crop variety combinations that have been extended over nearly 200 million mu, with yearly output increases of 10 billion kg, illustrating the enormous role of biotechnology in promoting socioeconomic development. However, our biotechnology development at present depends mainly on government allocations and agricultural enterprises or seed companies still lack an understanding of this type of competition and an interest in investing. Research work lacks vitality and the finished products bred by breeding units do not receive economic compensation. From the strategic perspective of long-term development and international competition, there should be clear provisions in the "Seed Law" concerning the responsibility of seed enterprises to invest in biotechnology breeding to increase the scientific understanding of enterprises regarding adoption of new technology and accelerate the breeding of improved crop varieties.

D. Establish development mechanisms

The application of biotechnology to improve crop varieties requires coordination of many disciplines. Establish open-type research offices and laboratories from the center to local areas with a division of disciplines and a division of levels, conduct personnel and equipment exchanges, and foster our personnel, instrument, and equipment advantages to the greatest possible extent. All of the relevant biotechnology institutes in the CAS have announced that they are establishing research laboratories open to China and foreign countries and this will undoubtedly promote the development of biotechnology in China. All breeding units also must destroy the closed breeding model of being small but complete, use local characteristics as a basis for clarifying objectives in attacking key problems, open up research offices and laboratories, foster the advantages of each, have prominent foci and make joint attacks on key problems, form multidisciplinary expert groups, make breakthroughs in the two areas of biotechnology development and improvement of varieties, and provide material guarantees for agriculture to move up to a new stage.

[references omitted]

Profile of Shanghai Institute of Microbiology

92FE0029D Beijing GUANGMING RIBAO in Chinese 30 Aug 91 p 4

[Article: "A Research Institute That Has Made Important Contributions to China's Fermentation Industry—A Brief Introduction to the Shanghai Municipality Industrial Microbiology Institute"]

[Text] The Shanghai Municipality Microbiology Institute is a specialized research organization that is engaged in applied and development research in microbial enzyme engineering and fermentation engineering. The predecessor of this institute was the Shanghai Municipality Light Industry Institute's Food and Household Product Chemistry Research Office, which received a second-place State Science and Technology Commission scientific research achievement award in 1965 for its research project concerning glutamic acid fermentation. The institute was formally established here in April 1966.

The institute has continually developed and grown over the past 25 years. The new site of the institute on Xietu Lu covers an area of 4,773 m^2 with 6,500 m^2 of structures. It now has 270 employees including senior engineers, engineers, assistant engineers, administrative, and auxiliary personnel. The institute is mainly involved in the application of modern biotechnology and is engaged in industrial application research of microbiology and the development of new technologies and new products that are now promoting the development of China's fermentation industry and modern biotechnology industry.

Since the institute was founded, all of its S&T personnel have united together under extremely difficult conditions, pressed forward despite difficulties, studied assiduously, spared no effort in attacking key problems, and completed 128 scientific research achievements, most of which have been placed into operation in Shanghai and throughout China. Some 38 of its scientific research achievements have received state, ministry, and municipal level awards. Many projects have attained advanced levels within China and some projects have filled in blank spots in China and attained vanguard levels within China. A few projects have approached or attained advanced international levels. During the Seventh 5-Year Plan, the institute assumed responsibility for eight scientific research projects to attack key problems during the Seventh 5-Year Plan and all of them were completed on schedule. They received many commendations from leaders in the State Science and Technology Commission, Ministry of Light Industry, Shanghai Municipality, and other levels. Among them, pure starch direct souring of citric acid, fermented bean curd plant waste water treatment, 5-guanylic acid fermentation research on the fermentation production of guanosine, and others attained or approached advanced international levels. Heat-resistant alpha-amylase, lysine high-yield bacterial strain selective breeding, glycosylase high-yield bacterial strain selective breeding, and other projects attained vanguard levels in China.

From 1979 to 1990, the institute made compensated transfers of 97 scientific research achievements to 340 units in 28 of China's provinces, municipalities, and autonomous regions for a contract volume of 6.876 million yuan and an achievement extension rate of 80.17 percent. Among them, the Citric Acid Topical Group renewed its bacterial strain five times in 20-plus years and increased the acid production rate from 7 to 8 percent up to 18 to 20 percent. After the relevant research achievements were extended throughout China, over 80 percent of the citric acid plants in China adopted this institute's bacterial strain and technology and formed a new production industry throughout China that changed the situation of China's reliance on citric acid from imports to exporting to many countries and regions and earning large amounts of foreign exchange for the state. Using just the fourth-generation bacterial strain C0827 as an example, statistical data for 1985 indicate that the citric acid plants in China that adopted this bacterial strain produced a total of 42,000 tons of citric acid during that year, for a value of output of 168 million yuan, total taxes of 42 million yuan, and export foreign exchange earnings of as much as $29.4 million. Moreover, between 1986 and 1990 this institute provided technical consulting services to 57 units throughout China and received an economic income of 265,000 yuan. The institute has also undertaken broad-ranging technical and economic cooperation with universities, research institutes, and companies in France, Germany, Japan, the United States, and other countries with satisfactory results, and it has earned an economic income in excess of $300,000. For the past 10-plus years, the institute has actively transferred S&T achievements to and undertaken technical and economic cooperation with production units in China and foreign countries and created substantial economic and social benefits that have provided a solid economic foundation for the institute to promote reform of the S&T system and gradually achieve economic independence. Moreover, it has improved the institute's status in the industry in China and generated a definite impact internationally.

Since 1978, the institute has sent over 10 S&T personnel for inspections, advanced training, studying for degrees, and cooperative research to the United States, Japan, Canada, England, France, Germany, Austria, and other countries. At the same time, it has also invited and accepted experts and professors from over 10 countries to come to visit and lecture at the institute. All of these activities have expanded the vistas of the institute's S&T personnel and improved their S&T levels, and they have increased mutual understanding and friendship between the institute's S&T personnel and scholars in all countries of the world. Starting in 1988, institute director and senior engineer Ju Nailu [1446 0035 3822] has been listed in 10 lists of renowned persons edited and published by England's Cambridge International Biographic Center, the United States Biographic Research Institute, and so on and won international fame for the institute. Many years of hard working cultivation and rich experience in the fields of fermentation technology and biotechnology as well as frequent contacts and scholarly exchanges with scientists in foreign countries have made the institute one of the most important research organizations in the field of industrial microbiology in China and given it a rather high reputation in international industrial microbiology circles.

The institute currently has five research laboratories. Research Laboratory 1 is mainly involved in research on microbe production and applications (such as high temperature-resistant alpha-amylase, glycosylase, protease, pectase, acidic amylase, and so on) and enzyme and cellular fixation and applications (for example, using fixated glucose isomerase to produce high-fructose syrup, using fixated bacterial cells to produce L-aspartic acid and L-alanine, using fixated yeast growth cells to produce beer, and so on). Research Laboratory 1 is also involved in research on genetic engineering and biosensors. Examples include cloning and expression of beta-cyclodextrin-glucoside transferase gene and "second generation" glucose oxidase electrodes.

Research Laboratory 2 is involved in research on new fermentation and production technologies for organic acid products including citric acid, L-lactic acid, gamma-linolenic acid, itaconic acid, L-malic acid, calcium gluconate, lactic acid bacterial nutrient liquid, beta-carotene, and so on.

Research Laboratory 3 focuses on research on fermentation and production technologies for amino acids (such as glutamic acid, L-lysine, L-proline, etc.) and nucleotide materials (such as inosine, guanosine, 5-inosinic acid, triazanucleides, etc.) and the fermentation and production of alcohol using fresh starch.

Research Laboratory 4 is engaged in research work on developing mildewproofing, antisepsis, waste water treatment, and biomass energy resources (marsh gas or methane).

Research Laboratory 5 is involved in research on separation, purification, and other downstream engineering as well as fermentation plant engineering design and other items of work.

The institute also has three centers:

1. The National Industrial Microbe S&T Information Station, which is responsible for collection, exchange, and research of national industrial microbes S&T information and data and publication of the bimonthly journal GONGYE WEISHENGWU (Industrial Microbes) that is openly distributed in China and foreign countries.

2. The National Industrial Microbes Bacterial Strain Preservation and Management Center's East China Station, which is responsible for collecting, preserving, examining, managing, exchanging, and supplying industrial microbes bacterial strains to the east China region. It now preserves over 700 bacterial strains including bacteria, yeast, and fungi.

3. The Shanghai Municipality Fermentation Industry Quality Inspection Center Station, which is responsible for inspection and quality supervision of fermented products from the Shanghai region.

To provide staple fermented products to the domestic and foreign markets, the institute is now building a nucleic acid product industrial experiment base. This base is located in the Caohejing New Technology Development Zone and covers an area of 9,300 m^2 with structures of 5,760 m^2. This base will work on optimization of drying conditions in the laboratory, promote the transfer of laboratory scientific research achievements into industrial production, and produce high quality fermented products for the domestic and foreign markets.

Institute address: 1515 Xietu Lu, Shanghai [Photo 1 caption]: Senior engineer Ju Nailu [1446 0035 3822], director of the Shanghai Municipality Industrial Microbiology Institute.

To colleagues in China and foreign countries:

On the occasion of the 25th anniversary of the founding of our institute and its move to a new site on Xietu Lu, I want to express our sincerest gratitude on behalf of all the personnel in my institute to colleagues in China and foreign countries who have cooperated with and supported our institute.

We will continue to adhere to the purpose of "opening up innovation, valiantly attacking the peaks, standing firm in Shanghai, and orienting toward the world", strive to promote the conversion of scientific research achievements into forces of production, and serve the development of the fermentation industry and modern biotechnology industry in Shanghai and all of China. At the same time, our institute earnestly desires to undertake cooperative research and development with universities, research institutes, and corporations in foreign countries for new technologies and new products in which they are interested. We are willing to transfer our scientific research achievements to plants in foreign countries or to use existing achievements of our institute as a foundation for further development of joint research. We warmly welcome foreign investors to join together with our institute on the basis of equality and mutual benefit to establish joint investment enterprises to produce and supply international markets with fermented products.

[Signed] Ju Nailu

[Photo 2 caption]: The institute's experiment plant under construction.

[Photos 3 and 4 captions omitted]

Yinguang Chemical Industrial Corporation Profiled

92FE0029C Lanzhou GANSU RIBAO in Chinese 14 Aug 91 p 1

[Excerpts from article by Lu Zhengwei [7627 2973 5524]: "The 'TDI' Song—A Record of Yinguang Chemical Industry Corporation's Second Undertaking"]

[Excerpts] TDI, a colorless transparent liquid with a viscosity 3 times that of water, has brought glory to the history of the Yinguang Chemical Industry Corporation's second undertaking.

Outside of the thick earthen red walls of a mystical "little castle", several palace-like industrial structures covering an area of 28.6 hectares thrust magnificently into the sky. Corridors of pipes, forests of towers, scaling ladders, and small bridges over pipes form a colored pipeline structure a total of 100 kilometers long that constitutes a modern-flavored "multi-storied pavilion". This is the TDI facility, a key state construction project for the Seventh 5-Year Plan.

The TDI production line, which has an annual production capacity of 20,000 tons, was completed and placed into operation by the Yinguang Corporation on 20 March 1990 and it moved Yinguang into the ranks of the 15 nations in the world that produce TDI, ending the situation in which China had relied for a long time on imports of this product. Not long ago at the National Conversion from Military to Civilian Production High Technology Export Product Exhibition and Trade Fair, the TDI produced by Yinguang won a gold medal for high quality and for filling in a blank spot in China. Since April 1991, the TDI load and continuous operation time set the best levels since it was placed into operation and daily output has now reached 52 tons.

TDI is the English abbreviation for toluenediisocyanate ester, which is mainly used for manufacturing polyurethane foam plastic and is also an important raw material for high-grade paints, adhesives, elastics, synthetic rubber, synthetic fiber, and other products. Before Yinguang began producing TDI, there were just a few plants in China that produced small amounts and the technology was extremely backward. As a result, all of China's soft foam producing

plants were forced to purchase imports from foreign countries at a cost of more than $2,000 per ton. The reason that Yinguang selected this high-tech precision chemical industry project was that the primary material used to produce TDI was an intermediate product from a military TNT production line that Yinguang produced year-round. Still, it was not easy to obtain this key state project which required an investment of 416.8 million yuan and generated 60 to 80 million yuan in profits and taxes each year.

The earliest pioneers at Yinguang left Beijing 38 years ago and chose a plant site at a place called Langwo 90 kilometers from Lanzhou. At that time, there were just three households and three elm trees at the site that reflected sandy hills during the cold months. [passage omitted] Today, 38 years later, there are now six military product production lines here and most of its 30- plus products are the sole ones in China. Its output accounts for 60 percent of China's total output in the industry and some products are sold throughout the world.

For a while, Yinguang relied on popsicles, ice cream, making crushed garlic cans, plaiting mops, and building furniture for its livelihood. Conditions forced them to find a second undertaking for more than 7,000 employees. Overnight, they fixed their sights on TDI, which was at advanced world levels. To fight for this project, the corporation's general manager comrade Tong [0157] consistently sought out leaders from the relevant departments of the central government and eventually defeated his opponents in competition with advantages like a large tract of land, relatively sufficient electric power, and local sources of water, coal, coke, and chemical industry materials.

The main facility for TDI was imported from Germany's BASF Corporation. The matching gas purification facility was imported from Japan's Mitsui & Co. Ltd. and the hydrochloric acid electrolysis facility was imported from Germany's Woodall Corporation. They have a high level of automation and a complex production technology, and there are 3.35 million sheets of printed data that were translated and copied. The preparatory work and negotiations with people in foreign countries lasted for 5 years.

The negotiations were successful. The China Huanqiu [Transworld] Design Company quickly obtained the blueprints and got to work as soon as possible on preparing the equipment and materials. Ground was broken for the TDI production line on 1 July 1986 and State Council member Zou Jiahua [6760 1367 5478] personally laid the foundation stone for the project at the site. More than 1.2 million cubic meters of earth was transported by over 100 small tractors and six big construction enterprise crews entered the site. There were about 5,000 working at the peak, including civilians. The mind of construction commander Bao Shikang [7637 0013 1660] was like a database. He worked overtime more than 100 days a year and had to travel over 10 kilometers each time he went to a different construction site. People from foreign countries who came here from all over the world for coordinated joint testing were convinced by their set of scientific management methods and they even exceeded the expectations of higher level administrative departments in Beijing. The people of Yinguang said that the TDI projects in Shanghai and Shanxi are falling behind us and the one who corners the market first will be the one who profits first, so why shouldn't we work hard?

After 4 years of arduous efforts, the TDI finally went into production victoriously and attained a purity rate of 99.8 percent. By the end of 1990, the 2,246 tons produced at Yinguang had been sold out. They have already produced 2,516 tons during the first 4 months of 1991. Users have ordered as much as 30,000 tons since it went into operation and some users have the money and are waiting.

The unique skill involved in Yinguang's second undertaking was "reverse development". They broke with the convention of first producing raw materials and then producing products. They used the foreign exchange from military products to import raw materials and produce finished foam plastic and placed it on the market, earned some money, and then established their TDI production line. The foam plastic plant with an annual output of 2,000 tons was completed and placed into operation in 1984 and its products were sold in more than 20 provinces and municipalities as well as exported to foreign countries. This foam plastic plant served as the tap and they built a dispersed integrated unit composed of 48 enterprises in Gansu Province that promoted the development of local industry. Yinguang was promoted to a province-level enterprise in 1987. The people of Yinguang are silently offering tribute and tirelessly struggling, using patriotism and high S&T to construct China's backbone.

Work of Pharmaceutical Plants Outlined

Harbin Baitiane Pharmaceutical Plant

92FE0117A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "Introducing Harbin Baitiane Pharmaceutical Plant"]

[Text] The Harbin Baitiane Pharmaceutical Plant is a joint venture of state and foreign capitals. Located in the center of the city, its address is 53 Hanguang [3352 1684] Street, Nangang [0589 1511], Harbin.

Established in 1986, the Harbin Baitiane Pharmaceutical Plant is backed by a fixed capital of 6.2 million yuan and employs 210 people. There are four senior engineers, six engineers and 14 technicians; the professional staff makes up 11.4 percent of the personnel. The plant encompasses more than 20,000 square meters, with 8,000 square meters built area. The grounds are wide open, dotted with shades of trees and the center grass tract, measuring some 10,000 square meters, is encircled by a cement driveway.

The manufacturing facility in the plant, which meets the national GMP standard is well-equipped with 15 state-of-the-art imported instruments, including a medium-sized, box-type super-filtration system, sterilization filtration system, reverse-osmosis super-pure water-purification

system, CO_2-incubator, freeze ultracentrifuge, freezer (-85°C), pH meter, electronic analytical balance, and UV-visible spectrometer. These instruments are complimented by 40 other advanced, domestic-produced scientific equipments.

There are three manufacturing shops, a research laboratory and a central quality control laboratory on the premises. Pharmaceuticals in various forms, either as basic drug or processed into tablets, capsules, ointments, as well as lyophilized biochemical and ampuled preparations for injections are produced here. The product line boasts over 100 different items. In addition to the 50 tons of basic drugs produced by chemical synthesis, the plant also turns out 300 million tablets, 100 million capsules, half a million tubes of ointments and 6 million lyophilized injection preparations every year. In 1990, our total output value amounted to 40 million yuan which brought 4.5 million yuan business taxes for China. Over the past several years, in its drive to develop advanced technologies as well as products with high added-values, China has adopted many new technologies and manufacturing techniques and made a substantial effort to expand the product development. New products, such as interferon, calf thymosin, transfer factor, human chorionic gonadotropin, urokinase, pit viper Kangshuanmei (anti-embolism enzyme), cytochrome C, prostaglandin E_1, ribavirin and polyinosinic acid. All of the products are manufactured according to the standards in the China Pharmacopeia of the 1985 edition and they are distributed nationwide through a network of 360 exclusive dealerships that covers the 29 provinces, municipalities and autonomous regions. One of the plant's new products, the human chorionic gonadotropin, has been introduced into the international market.

In the five years since its establishment, the Harbin Baitiane Pharmaceutical Plant has been recognized for its achievement by many honorary titles, such as the Third Class Quality Control Model, Third Class Standardization Model, Second Class National Quality Control Model, Heilongjiang Provincial Advanced Health Organization, Heilongjiang Provincial Advanced Enterprise, Heilongjiang Provincial High-Tech Enterprise, Heilongjiang Provincial Leading Health Care Product-Developing Organization and Military Advanced Enterprise.

The plant's products have been honored by many awards. For instance, the human chorionic gonadotropin has received the Second Class Heilongjiang Provincial Award for the Advancement of Sciences and Technologies, First Class Heilong-Cup Award, Product Excellence Award from the Shenyang Military District and the Silver Award in the National High and New Technologies Exhibition; the calf thymosin was awarded the Second Class Heilongjiang Provincial Award for the Advancement of Sciences and Technologies in Health Care Industry; interferon, the New Product Certificate and the basic drug Fenbufen [5358 1580 5389] the Second Class Heilongjiang Provincial Award for the Advancement of Sciences and Technologies.

In addition to the plant's commitment to improve the quality of its products, it is also employing biotransformation technologies, fixation technologies, genetic engineering and cellular engineering technologies to develop new products, such as purified interferon of human white cells, recombinant interleukin-2, HCG monoclonal antibody diagnostic kits as well as human serum albumin and globulin.

Chaohui Pharmaceutical Plant, Second Military Medical University

92FE0117B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "Chaohui Pharmaceutical Plant of the Second Military Medical University Forges Ahead"]

[Text] The Chaohui Pharmaceutical Plant of the Second Military Medical University was founded in 1985. Through continued expansion in the past 30 some years, the Chaohui Pharmaceutical Plant has grown into an integral component of the combined-operation system of teaching, research and development, and manufacturing of the School of Pharmacology of the Second Military Medical University.

Of the 11,782 square meters occupied by the factory, an area of no less than 9,976 square meters is devoted to production. The plant has the capability to produce synthetic basic drugs, extracts and injections, capsules, oral preparations, bagged IV solutions, ointments as well as sprays and inhalers of Chinese herbal medicines. The recent dedication of a new manufacturing facility of 5,000 square meters, constructed to the modern requirements for pharmaceutical production, has doubled the plant's output capability and enabled it to exercise better quality control over the products. The plant has become a core pharmaceutical manufacturer of the military.

The plant is well equipped with analytical instruments for quality control purposes. In addition, the close collaboration and support from the Central Instrumental Analysis Laboratory of the School of Pharmacology of the Second Military Medical University have enhanced its ability to maintain a high standard for the quality of all of the products and to assure their effectiveness.

The Plant's Major Products

Basic drugs: bupivacaine hydrochloride, sodium citrate (injection), lidocaine hydrochloride (injection), benzphetamine hydrochloride and propylthiouracil.

Tablets: phenelzine (sulfate) tablets, Luding [5864 0002] multi-formula tablets, Shui Fei Ji Su [3055 7378 5636 4790] tablets, ketoconazole and multi-formula sulfamethoxazole tablets.

Injection preparations: lidocaine and acetaminophen.

Oral preparations: Shanghai Brand essence of ginseng with bee milk and Shengmai [3932 5181] Drink.

Spray preparations: They are mainly used for relief of asthma.

The plant is currently developing new products and seeking new markets so as to be able to provide more and better products as well as services.

Address: 325 Guhe [0948 0735] Road, Shanghai.

Factory Director: Zhang Lin [1728 7792].

Blood Products Research Institute, Air Force Logistics Department

92FE0117C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "The Steadily Growing Blood Products Research Institute of Air Force Logistics Department"]

[Excerpts] The Blood Products Research Institute of the Air Force Logistics Department is located in the suburb of the city of Zhengzhou in Henan Province, right in the heart of the Central Plain and is easily accessible. The institute is the sole core-outfit for blood products R&D of the Air Force. Ever since its establishment, the Blood Products Research Institute has been steadily growing under the kind patronage and support from the General Logistics Health Department and the Logistics Department of the Air Force as well as the assistance extended by blood product experts and colleagues in this field. The research institute was inspected and approved by experts from the Department of Public Health in May 1990. The institute is holding an admirable zero-accident record in 87,147 blood transfusions and in separating and fractionating 35.07 million ml of plasma. It has comprehensive expertise and technologies, advanced instruments and complete monitoring equipment to maintain reliable qualities of blood products and to assure their sale and efficient clinic applications. The institute's major products include human serum albumin, human γ-globulins and lyophilized human plasma; approximately 20 percent of the human globulin product has been evaluated as Product of Quality of Armed Forces. Its commitment is quality, the customers' trust and the good name of its products. [passage omitted]

In order to meet the demands of modernizations of China and the rapid development of the health care industry, the institute will remain committed to comprehensive quality controls to maintain the high standards of products, pursue and develop new products in various configurations with improved specifications and better packaging. In addition, it will upgrade existing products, to meet international standards. Its goal is to fulfill its obligations to the Air Forces and to the Chinese blood product industry.

Beijing Xinkang Pharmaceutical Plant

92FE0117D Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "Introducing the Beijing Xinkang Pharmaceutical Plant"]

[Excerpts] The Beijing Xinkang Pharmaceutical Plant (Chinese People's Liberation Army Factory Number 9018) is a subsidiary enterprise of the Logistic Department of the Beijing Military District; therefore, an enterprise of all the people. It is located in Zui Gong Fen [6816 0361 0970] in the Chao Yang [2600 7122] District, occupying no less than 17,000 square meters, with 7,000 square meters built area. The plant has broad expertise and strong technical capabilities, coupled with advanced manufacturing technologies and supported by complete monitoring facilities. The plant is equipped with a solid processing workshop, a liquid processing workshop, extraction workshop and a raw-material purification facility. The plant offers 34 products of uncompromising quality in 41 specifications. In addition to meet the demands of the domestic market, its products have been exported to many areas of Europe, South Africa and Southeast Asia. Recently, it made more investment to develop new products. [passage omitted]

The plant's major products are:

Erythromycin succinate and medemycin tablets, aminobenzylcephalosporin tablets, syrup for nourishing Yin and clearing the lung-heat, agastachis solution for restoring health, dihydroxynaphthyl pyrimidine syrup, multi-formula stringy stonecrop syrup, cold-cough syrup, ferrous furmarate tablets, vitamins A and D drop preparations, acetylspiramycin tablets, sulfamethoxazole (sinomin) multi-formula tablets, essence of coptis root hydrochloride tablets, ketoprofen tablets, chloromycetin tablets, quick-action cold tablets, weitishu [4850 7155 5289] tablets, ranitidine hydrochloride tablets, loquat cough syrup, stringy stonecrop multi-formula syrup (concentrated form), tugen [0685 2704] syrup, children formula expectorant and cough syrup, cold and cough syrup, loquat cough extract, essence of ginseng and nutgall oral preparations, wei vitamin-phosphorus tonics, acetic acid-wash-and-heal baby powder and sodium acetate (medical purposes).

Jinxi Bohai Pharmaceutical Plant

92FE0117E Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "Introducing the Jinxi Bohai Pharmaceutical Plant"]

[Excerpt] The plant (Chinese People's Liberation Army Factory Number 9407) was founded in April 1970. It is located in the Long Wan [7893 1737] District of Jinxi, Liaoning [6-6-5]. This area is bounded by the green mountain on one side and faces the Bohai on the other, presenting a picturesque scenery. The Jinxi Bohai Pharmaceutical Plant employs 250 people and is backed up by a fixed capital of 2.5 million yuan and a liquid capital of 1.6 million yuan. Its annual output amounts to some 6 million yuan. There are five manufacturing workshops in the factory. The major products are: yellow and white vaselines, febrifuge and pain-killing tablets, stomachic tablets, multi-formula sugar-coated stomachic tablets, multi-formula sulfamethoxazole (sinomin) tablets, chlorpromazine, alginic acid diester sodium tablets, acetylspiramycin tablets, norfloxacin capsules, terramycin capsules, quick-action cold capsules, iodine-complex ketone, iodine-complex ketone solutions, iodine-complex ketone vaginal suppository, xinjieermie [2450 3381 3643 3319] solutions, methyl blue solutions and iodine tincture.

The plant's yellow and white vaselines (their quality has already met the specifications described in British Pharmacopeia) were first introduced into the international market in 1980. It now exports several hundred tons of vaselines every year. They had also received the Good-Quality-Product Award from the General Logistic Department (of the People's Liberation Army) in 1988. Iodine-complex ketone was first listed in the Chinese Pharmacopeia of the 1990 edition; it works better than the iodine tincture it is replacing. It exhibits a stronger and longer-lasting antiseptic effect, has no side effects and is non-irritating. This agent does not cause as much pain when applied to the wound. It forms a thin protecting film over the affected area and can be used to treat mucosa. In addition, there is no need to remove excess iodine when sterilizing the part of skin for injection with iodine-complex ketone, making it easier to use. The vaginal suppository of iodine-complex ketone is effective against different forms of vaginal infection, including the chronical type; its efficacy has been proven, exhibiting an effective rate of 100 percent and curing rate of 90 percent. Alginic acid diester sodium salt is noted for its effect in removing blood fat, expanding blood vessels, improving microcirculation, lowering blood pressure and reducing the level of blood sugars. It showed an effective rate of no less than 92 percent against all cerebral thrombosis. [passage omitted]

Changchun Beifang Pharmaceutical Plant

92FE0117F Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 6 Oct 91 p 3

[Article: "Changchun Beifang Pharmaceutical Plant Is on the March"]

[Excerpts] Changchun Beifang Pharmaceutical Plant was established in 1987; at a time when the national economy was overgrown, the money tight and the market soft. Because of the bad time and poor management, the plant was plunged into a difficult situation of "Four Abundance and Four Scarce." [passage omitted]

However, the Party Committee of Changchun Veterinary University took firm action in May 1990. The managing team was reorganized. [passage omitted] It reported an earning of 1.1 million yuan for the first six months of 1991 and became one of the 10 best performed pharmaceutical plants in the city. [passage omitted]

Improve the training of sales team, develop science and technology product promotions, open up new business channels and explore uncharted markets. [passage omitted]

Realign the product structure and develop core products. In order to be able to better serve the customers, the university leadership, with the assistance of the faculty and the staff from the plant, reorganized the production infrastructure; dispersed units were aggregated into a more orderly body, for instance, the biochemical factory was transferred from the Research Institute of the University to Beifang Pharmaceutical Plant. The streamlined administration system helps raise production efficiency. At present, the plant is offering a wide variety of products, in addition to the core products such as the internationally recognized quick-healing plasters for falling and beating injuries and the thymosin injection solutions, which is considered one of the best in its class, there are more common drugs like analgin, terramycin and tetracyclines; quick-action expectorant and cold medicine, seasonable for fall and winter and xinliling [2450 4031 7227] (the wonder drug for dysentery); the plant carries not only many traditional Chinese herbal medicines but also many Western synthetic drugs.

PLA Progress in Burn Research

92FE0118B Beijing JIEFANGJUN YIXUE ZAZHI [MEDICAL JOURNAL OF CHINESE PEOPLE'S LIBERATION ARMY] in Chinese Vol 16 No 4, Aug 91 pp 274-277

[Article by Yang Zongcheng [2799 1350 1004] and Li Ao [7812 7663] of the Burn Research Institute, Third Military Medical College]

[Text] The People's Liberation Army began its burn research in 1958 and the subject has remained as an important topic of the PLA's military medical research. Under the direction of the Army Special Burn Unit, research units of the Army worked together to tackle difficult problems. Investigations were conducted for inhalation damage, burn shock, infection, wound treatment, and internal organ complications after burn. The major advancements made in this research have kept China in the leading position in the treatment of burns.

Basic Research in Burn Has Formed a Complete Academic Discipline

I. Inhalation Damage

As the treatment of burn shock and infection improves, inhalation damage becomes the most threatening factor. The study of inhalation damage here and abroad has been scattered and slow. The PLA began investigating inhalation damage in 1979 and conducted extensive research, with more than 100 papers published. The pathological and physiological changes were classified, the trigger mechanism for early pulmonary edema was understood, and preventive measures were investigated. The major results include: (1) Duplicated a number of stable vapor and smoke inhalation animal models. (2) Reproduced, for the first time in China, sheep chronic pneumolymphatic fistula and observed the dynamic pulmonary humoral exchange using a lung-water meter. (3) Developed a pulmonary surface tension device and launched research for surface active matter of the lung. (4) Made systematic observation of the pathological morphology changes and verified the major pathological changes of chemical tracheitis and bronchitis, and pulmonary edema and atrophy. (5) Clarified blood dynamics and changes of lung functions in burn victims. (6) Explained the stages of the course. (7) Using optical and electronic microscopy and freeze-etch reconstruction technology, the formation of fissure between endothelia cells of the pulmonary capillary after burn injury was discovered. Combined with changes in

pulmonary lymph-stream and the lymph-blood plasma protein ration, the permeability of pulmonary edema was verified. (8) The effects of more than 30 humoral factors on pulmonary edema were investigated and the mechanism for edema was basically explained. (9) Based on clinical conclusions and animal tests, the traditional practice of restricted early intravenous transfusion in burn injury with inhalation damage was disproved. (10) After inhalation damage there are likely pulmonary infections. Infections play an important role in respiratory function failure. (11) First use of fiber bronchial scope in China for diagnosing inhalation damage. (12) Animals with smoke inhalation injury were treated with a combination of Chinese and Western drugs including antioxidizer ginseng saponin and ibuprofen. The survival rate was improved and the occurrence of edema has decreased.

II. Study of Mechanism of Burn Shock and Its Prevention

Shock has already been a major topic in burn research. The PLA has studied burn shock extensively and the major achievements are as follows: (1) Hemodynamic changes after burn injury have been carefully observed since the 1960's. In addition to a drop in the circulatory blood volume, the pumping function of the heart was also reduced in the short term. The contraction and dilation of the heart muscle were also affected. The blood in the heart muscle is decreased locally. (2) The permeability of the capillary increased after burn injury. The increase also became obvious at distant locations one hour after the burn injury. Drugs that may be used in reducing permeability and edema include methyl cyanide imidopiperidine, PAF antagnostic agent CV3988 and luteolin and quercetin, which fight osmosis and alleviate edema. (3) Burn injury causes obvious microcirculation change. The blood flow slows down, turning into particulate and thread-like flow, and gradually thickens. The viscosity of the blood increases. (4) After the burn injury, white cells cling to the wall of small veins and increase the resistance of blood flow. The flow in capillaries gradually stops. (5) Investigated the pathogenesis of the nerve-humeral factor, emphasized the study of the discharge of sympathetic and vagus nerves, changes in the hypothalamus-pituitary system, and changes in autogeneous opioid material, catechol phenoamino, adrenalin, angiotensin, platelet activation factor, and adrenalin receptor. (6) Cytological factors in burn shock were studied, including respiratory function changes of the mitochondria, the drop in ATP and the increase of lysosome, and the drop of the Na-K ATP enzyme of cell membrane. (7) The various burn centers of the PLA have all developed their own fluid infusion formula. (8) Extensive study of the composition for early fluid infusion was made. It was proposed that early replenishment of whole blood was beneficial, and phased fluid infusion and oral fluid infusion were investigated.

III. Burn Infection Mechanism and Treatment

1. Entero-Infection After Burn Injury

In the past, the emphasis was on the invasive infection of the wound surface. With the application of effective external medication such as silver sulfapyridine, the number of deaths due to direct surface infection has decreased. Entero-infection due to the invasion of enterobacteria and endotoxin through the entero mucous membrane has become a concern. The PLA has made systematic study of entero-infection and obtained the following major results: (1) It was verified that, after the burn injury, aerobic bacteria, anaerobic bacteria and fungi can all enter the body through the enteral path. (2) The important enteral infection mechanisms are disruptions of the enteral bacteria group, damage of the mucous membrane, and the reduction of the immunity. (3) Endotoxemia, malnutrition, and shock can all promote enteral infection. (4) Using electron microscopy and freeze-etch method, it was shown that endotoxemia promotes enteral infection mainly by increasing the permeability of the enteral mucous membrane. (5) Phagocyte and alexin participate in the occurrence of enteral infection. (6) Antioxidant and polymyxin B can prevent enteral infection.

2. Study of Burn Infection Diagnosis

In the early 1960's, the PLA made clinical studies of early diagnosis of burn septicemia. The deduced rules from those studies played an important role in the prevention of infection. In the 1970's, the PLA was among the first in China to make histo-bacteria counts under charred scabs. The PLA has made detailed descriptions of the clinical representation and pathological changes of fungal infection, and improved the positive rate using a strip-culture method for fungi. Anaerobic bacteria have recently attracted some attention, but the PLA had studied the infection of anaerobic bacteria in burned injury long before this. The PLA has also developed its own culture apparatus and used an indirect fluorescence method for the diagnosis of anaerobic bacteria.

3. Treatment of Burn Infection

In the 1960's the PLA developed the hibitane. In the 1970's they studied N-metal sulfonamides and the silver, zinc and cerium salts of anxiesu [2542 1400 4790], in addition to silver sulfapyrimidine. In the 1980's the PLA developed silver pyrene and iodoph thaleium, both very effective in treating burn infection. The PLA has also cooperated with local units in the development of vaccines for Bacillus pyrocyaneus and Staphylococcus aureus, and immunoplasma for B. pyrocyaneus. These results have been effective in the prevention and treatment of burn infection.

IV. Management of Wound Surface

1. Investigation of De-Scabbing Indications for Early De-Scabbing and Skin Graft

In China the cure rate has been improved by the practice of early de-scabbing and large area coverage by the hetero-transplant interdispersed with auto-skin graft. The large hetero-skin preparation method developed by the PLA in the 1960's served as the basis for this operation. In recent years the procedure was simplified by the invention of a roller cutter for small skin. The PLA has made systematic

study of small skin growth and hetero-auto alternating grafting of skin. Some unique understandings have been acquired.

Although de-scabbing is widely practiced, the indication is still not definitive. The investigations made by the PLA on the indications and precautions of early de-scabbing and de-scabbing during the septicemia period have effectively guided the clinical work.

2. Efforts To Broaden the Source for Skin Graft and To Improve the Survival Rate of Skin Transplant

In the treatment of large area burns, auto-skin is inadequate and hetero-skin is needed. In order to prolong the survival time of hetero-skin, the PLA treated the skin with fluorocortisone acetic ester, prepared and tested anti-human T-cell immunoglobulin, anti-murine monoclonal antibody and cyclosporin, and conducted clinical and animal tests with encouraging results.

In order to solve the problem of skin source, the PLA first succeeded in 1980 in the culture of epidermic cells of animals, followed by the successful culture of human epidermic cells and clinical tests. After repeated improvement, the culture technique can now produce stable epidermic cell layers that have a high survival rate on infection-free wound surfaces. The development of multi-layered epiderm has also begun. Research in this area by the PLA has approached the world advanced level. To date there have not been objective criteria in the culture of hetero-skin epidermic cell and transplant survival times. The PLA is exploring the use of immunohistochemical methods for the testing of blood type antigen of cells, and the use of polymerase chain reaction (PCR) testing of the Y chromosome specific DNA recurring sequence to determine the cell gender. This research will provide a scientific basis for the cultivation of heterocytes at the wound surface. The PLA research has also shown that the cultured epiderm lacked the HLA-DR negative Langhan's cells that are closely related to rejection. They also discovered that the blood type antigen of cultured epiderm was weakened. These may all be implicit reasons for the rejection of cultured heterocytes.

The PLA was the first to establish a skin bank in China and used liquid nitrogen to store skin specimens. It has since developed a method to store skin in RPMI-1640 at 4°C, and investigated the vitrified fast-freeze skin storage method, which increased the skin activity by 20 percent as compared to the slow-freeze method and raised the skin graft survival rate to above 90 percent. They have also explored simple skin storage methods including freeze-dried skin, glycerol skin, and pentadialdehyde skin with certain success. In the early 1970's the PLA also made the first transplant of large pig skin to a de-scabbed burn wound and developed a number of artificial skins with good clinical results.

V. Pathogenesis, Prevention and Treatment of Internal Organ Complications After Burn Injury

In the 1960's, the PLA investigated the clinical and pathological characteristics of internal organ complications of burn injuries. From the conclusions in the early studies, it was recognized that shock and infection were the main causes for internal complications. It was observed that damages to the glomeruli were the major pathological changes associated with late stage kidney failures. Also observed carefully were pathological changes in the lungs, heart, liver, and intestines. Multi-function failure (MOF) was first formally proposed in the 1970's. The PLA completed a post-burn multi-function failure investigation in 1978, followed by a series of clinical and laboratory studies. The following important results were obtained: (1) There were two types of MOF: early MOF and delayed MOF. Early MOF was mainly caused by shock, and delayed MOF was mainly caused by infection. (2) The occurrence and development of MOF involved the activation of the complement system, allergic toxin, free oxygen radicals, and prostaglandin. (3) Entero-infection played an important role in MOF. (4) A weakening of the liver function, particularly a reduction of the Kupffer cell function, can induce the failure of other organs. (5) Dysfunction of the mitochondria metabolism was the basis for MOF. (6) Appropriate replenishment of body fluids at an early stage and timely intervention of shock may prevent MOF. (7) Early attention to the nutrition of digestive system may reduce damages to the intestinal mucous membrane, which helps to prevent entero-infection and MOF. (8) The pathological basis for MOF was inflammatory reaction of internal organs and histoedema.

VI. Mechanism and Treatment of Immunosuppression Caused by Burn Injuries

Systematic studies of burn-induced immunosuppression began in the 1970's in foreign countries. The PLA began its investigation of this subject in the late 1970's and found that both cellular and humoral immunity showed pronounced changes following burn injuries. Changes in cellular immunity included: (1) Based on the expression of various membrane receptors, the function of macrophage cells were found to suffer severe damages after a burn. (2) Measurements of the oxidation metabolism, chemical luminescence, and expression of Fe and C_{36} receptors showed that the phagocytic and germicidal abilities of the granulocytes were reduced after a burn. (3) Using in vitro bone marrow culture and in vivo spleen tuberculum test, it was found that the pluripotent stem cell of the bone marrow divided and grew at the expense of the granulomonocyte system. (4) Using the H-TdR infiltration method, a pronounced weakening of the growth reaction was detected in the lymphocytes against mitogen and lymphocytes of the same species. (5) The immunoadhesion ability of red blood cells after the burn was impaired.

Humoral immunity changes after the burn included the following: (1) Complement was activated and consumed after the burn. This reduced the bacteriolytic ability and increased the anaphylatoxin, leading to histologic damages and edema. (2) After the burn, the content of the fibrin in the blood plasma decreased. (3) Changes of acute stage protein and vector protein were related to the development of the injury.

The mechanism of immunosuppressions after the burn injury was investigated. It was found that cell groups with immunosuppressive activity appeared after the burn and there were inhibitors in the blood. It was also recognized that stress hormone participated in the immunosuppression in the early phase after the burn. Using an electrophoresis technique, anomalous composition with a molecular weight in the 17 to 45 kD range was found after the burn. Preliminary information attributed it to a serum factor detected by an antihaptoglobin antiserum.

In recent years, experimental studies have been made for the reconstruction and for improving the suppressed immune system after burn injuries. A number of drugs were found to have effects on the immune system. These included Chinese herbal medicines such as astragalus henryl, honeysuckle, knotweed, oldenlandia, wild chrysanthemum, dandelion, and rehmanniae. The effects were better when Western drugs such as ibuprofen, methyl cyanide imidopiperidine, and cerium nitrate were administered at the same time.

VII. Nutrition of Burn Patients and Measures To Improve the Nutrition

In the 1970's, the PLA first used an intensive intravenous nutrition treatment on burn patients. The PLA developed and promoted an essential diet program. It was found that the serum free amino acid spectrum reflected the changes of the total amino acid pool. After burn injuries, the nuclear transcription activity of liver and skeletal muscle cells increased. No large changes were observed in the cell membrane receptor combination rate in red cells, skeletal muscle cells, and liver cells; however, there was a pronounced decrease in the volume of the receptor combination. After burn injuries, the intestinal amino acid absorption rate decreased, possibly due to a drop in the Na-K ATP enzyme activity. When glutamine or accetone body were administered to the patient, the release of uria trimethyl histidine and the decomposition of skeletal muscle protein were reduced.

VIII. Phosphorburn and Other Special Burns

The PLA has made systematic studies of phosphorburn, developed animal models, and made whole body observations after phosphorburn. The PLA has also investigated the pathological foundation for kidney dysfunction after phosphorburn and found that the major change was in glomerulus. Studies have shown that the reduction of fiber ligandin was an important reason for the pathological changes of glomeruli after phosphorburn. Changes in the stomach and liver were also carefully observed and evaluated. The timing and method for wound surface treatment were compared and discussed.

For severe electrical burn, the practice in China has been thorough cleaning of the wound at an early stage and covering the wound surface as quickly as possible with various skin pieces. The treatment results were better than that in foreign countries. The PLA has also made some contributions to the treatment of electrical burns and gained some experience from it. In 1963, a case of third degree electrical burn with 45 percent of the area was treated and cured. This patient had extensive damage of the skull, the frontal bone was penetrated and led to aqua cerebrospinalis fistula, and there was a large area of abdominal wall destroyed, accompanied by intestinal and bladder fistula. Skin graft was performed on the hard meninges and skin was grafted on the omentum majus to replace the abdominal wall. Since 1963, a number of severely electrocuted patients have been cured.

China is rich in mining resources and gas burns are frequent occurrences. The PLA has summarized the characteristics of gas burns and noticed that gas burns are characterized by burn and impact composite injuries, accompanied by carbon monoxide and other chemical poisoning.

IX. Prevention and Repair of Burn Deformity

The treatment and prevention of burn conducted by the PLA has always been participated by plastic surgeons. The emphasis was on the restoration of function while improving the curing rate. The PLA believed in applying plastic surgical approaches in the early stage treatment of burn injuries and widely practiced early de-scabbing of deep burns. The PLA has obtained good results for treating facial burns with early de-scabbing and zoned large-area skin grafting. In recent years, skin flaps were widely used in the early restoration of burned surface (especially at functional locations) and obtained satisfying results. Most of the PLA members working on burn injuries are also engaged in the restoration of deformity in the late stage of the treatment. Plastic surgery of burn deformity involves many subjects and is a special discipline in itself. Major advances have been made since the beginning of the effort in the Korean War, and no further elaboration will be made in this article.

Make Extensive Use of Research Results, Improve the Treatment of Burn Injuries

For more than 30 years, the PLA adhered to basic research and insisted upon the clinical principle and the combination of research and treatment. They have continuously improved the burn treatment procedures and elevated the medical standards.

I. Based on Theoretical Research, a Unique and Effective Plan for Treating Burns Has Been Established

In the early 1960's, the treatment of burn injuries in China was heavily influenced by foreign practices. Too much emphasis was placed on the role of bacteria, thorough cleaning of the wound, rigorous separation and the administering of antibiotics. As a result, the management of the wound surface was neglected. The result was that further advances were impeded. In the 1962 clinical summary of burn treatment by the PLA, objections were raised against the practice at the time. It was clearly proposed that burn treatment must be based on the whole picture and attention should be given to the maintenance and improvement of the resistance. Emphasis was given to on-site treatment of shock. In the early phase after burn injuries, thorough scrubbing should be avoided and simple washing should be

done. Infection by contact should be watched, but rigorous separation should not be practiced. Bacterial survey should be done frequently and antibiotics should be administered accordingly. De-scabbing and skin graft should be done as early as possible. Recuperation methods of traditional Chinese medicine may be used and the oral intake of nutrients should be improved. The PLA formulated a system of effective treatment for burn injuries that suited the situation in China. This system has played a major role in turning around the passive situation at that time. In the mid-1960's, it was further verified that the wound surface was the major pathological change of burn injuries, and shock and infection were the main reasons of complications, and the direct predisposition for death. This concept and practice of treatment spread all over China very quickly and the major points are still in use today. After continuous expansion and perfection, the burn prevention and treatment methods of the PLA have become very unique here and abroad and they have acquired considerable influence. In addition, tens of new techniques and drugs for treating burns have been used widely in China. These included the new nine-zone method for measuring the burning surface area, the early fluid replenishing formula, the method to obtain and store large external-source skin, artificial skin, and freeze-dried skin. They also included the small rolling cutter for removing large areas of skin, the immersion method, the weight monitoring, the growth of the anaerobic bacteria, the surface tension meter for the surface of the lungs, and the oxygen consumption apparatus related to the measurement of the activity of the skin.

II. The PLA Cured a Large Number of Burn Patients With a Recovery Rate Among the Highest in the World

From 1958 to 1979, the 16 units of the PLA treated 48,978 burn patients and the recovery rate was as high as 95.07 percent. The half fatal-burn-area (LD_{50}) was 75.93 percent. Both figures were of the advance world standard at that time. Since 1980, the performance of PLA in burn treatment has improved again, the LD_{50} of several major burn treatment centers has approached or exceeded 90 percent. The PLA's treatment of large area deep burns is particularly superior to other countries. In as early as the 1960's, the PLA has cured patients with 68 percent of third degree burns. Later, a group of patients with more than 90 percent burns overall and more than 80 percent of third degree burns were also cured. There were even a number of cases where the patients suffered more than 90 percent of third degree burns. It is still rare in foreign countries that such severely burned patients are cured.

The PLA collaborates broadly with local medical units in treating burned patients. It participated many times in the rescue of batches of burn patients and saved tens of thousands of patients. The PLA has gained a wealth of experience from these activities.

III. The PLA Participates Extensively in Academic Exchanges Here and Abroad, Publishes Technical Papers, and Plays an Important Role in Promoting and Improving the Treatment of Burns in China

Ever since 1958, under the leadership of the PLA special burn group, a PLA-wide conference on burn injuries has been held every two years (except during the Cultural Revolution) for 13 times to date. In the six conferences after 1978, 1,983 papers were presented. In the National Conference on Burns, a substantial fraction of the papers were from the armed forces. In the two national burn conferences since 1978, a total of 725 papers were presented. Out of the total, there were 315 papers (42 percent) from the armed forces. In addition to exchanges in China, international exchanges were also widely conducted since 1978. The PLA has participated many times in international burn conferences held by burn societies in the United States and Japan. The PLA attended the international forum on burns held in Shanghai in 1981. The first and second China-U.S. conferences on burn treatment were held by the PLA and the American Burn Society in Chongqing and Beijing respectively in 1985 and 1989. These conferences made China and the PLA known and be recognized by the international community. A total of 513 papers were presented in the three international meetings held in China, 127 of which were from overseas and 386 of which were domestic papers. There were 264 papers from military units, which accounted for 51.5 percent of the total number of papers or 68.4 percent of the papers from China. The PLA played a major role in the academic exchange in these three meetings.

The PLA has already written and published a series of reference books on burns. Of particular significance were the two texts *Treatment of Burns* (People's Health Publishing House, 1977) and *Burn Treatment: Theory and Practice* (Liaoning Publishing House, 1988). These two books encompassed theory and practice and gave comprehensive reviews of the PLA's experience in burn treatment. They also discussed research on the subject in China and abroad and had considerable influence in China. For promoting and elevating the standard of medical treatment of burn injuries, these two books have played a very important role.

The Changes of STIs During Sitting Ergometry in a Simulated 350m He-O_2 Saturation Dive

40091009C Beijing ZHONGGUO YINGYONG SHENGLIXUE ZAZHI [CHINESE JOURNAL OF APPLIED PHYSIOLOGY] in Chinese Vol 7 No 4, Dec 91 pp 307-310

[English abstract of article by Lu Hai [4151 3189], Pan Mingda [3382 2494 6671], et al. of the Naval Medical Research Institute, Shanghai]

[Text] The results of the changes of STIs measured by ear densitography in four male divers (aged 20-22 years) during sitting ergometry in a simulated 350m He-O_2 saturation dive experiment were presented. The main changes under various pressure (300, 230 and 135m) and after decompression were increment of ICT, PEP and PEP/LVET ratio, which were found to be significantly different from the control values before compression. It is considered that these changes could denote an attentuated myocardial contractility due to the influence of this specific hyperbaric experimental condition.

Studies on Adaptive Controller for Controlled Hypotension

40091009B Beijing ZHONGGUO YINGYONG SHENGLIXUE ZAZHI [CHINESE JOURNAL OF APPLIED PHYSIOLOGY] in Chinese Vol 7 No 4, Dec 91 pp 289-292

[English abstract of article by Li Luping [2621 7627 1627], Wang Xingbang [3769 5281 6721], et al. of the Department of Aerospace Physiology, The Fourth Military Medical University, Xi'an 710032]

[Text] An adaptive control algorithm—the minimum deviation advance controller (MDAC) is presented. MDAC minimizes the variance between real output and set point at a time advance which is equal to or greater than the dead time. It can control type I and type II non-minimum-phase system with unknown or varying dead times fast, smoothly and steadily. MDAC maintained the mean arterial blood pressure of rabbits within +/- 0.67 kPa of the desired value at 95.8 percent of the time despite the presence of disturbance.

Site-Specific Mutagenesis Directly on the Double-Stranded Plasmid

40091010I Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 23 No 6, Nov 91 pp 527-531

[English abstract of article by Hu Ming [5170 2494], Yang Yi [2799 3015], et al. of the Shanghai Institute of Biochemistry, Academia Sinica, 200031]

[Text] A method of site-specific mutagenesis directly on the double-stranded plasmid was reported. The plasmid was first linearized near the target-site with a restriction enzyme and digested with *E. coli* exonuclease III to produce DNA containing the partial single-stranded region. The above treated DNA was annealed with the synthesized oligonucleotide, then filled and sealed with Klenow enzyme and T4 DNA ligase respectively. The mutant was screened by dot blot with the labeled mutant primer or digestion with restriction enzyme and then identified by DNA sequencing. It was demonstrated that by this method the efficiency of site-specific mutagenesis is over 30 percent.

Excimer Laser Radial Keratotomy and Its Experimental Studies

40091010J Shanghai YINGYONG JIGUANG [APPLIED LASER TECHNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 272-274

[English abstract of article by Yuan Cailai [3633 2088 0171], Le Yaokang [2867 5069 1660], et al. of the Shanghai Institute of Optics and Fine Mechanics, Academia Sinica, and Zheng Yiren [6774 0001 0086] and Zhang Zhen [1728 7201] of the Shanghai Railroad Center Hospital]

[Text] Mechanism of excimer laser radial keratotomy (RK) has been constructed. RK experimental studies of animals' eyes using ArF excimer laser by our own manufacture are conducted. Satisfactory results of RK are obtained.

Determination of Retinal Function by Use of the Laser Interference Technique

40091010K Shanghai YINGYONG JIGUANG [APPLIED LASER TECHNOLOGY] in Chinese Vol 11 No 6, Dec 91 pp 275-276

[English abstract of article by Xu Mingyu [1776 2494 3768] of the Shanghai Institute of Laser Technology]

[Text] A recent developed laser retinometer is introduced in this paper. It uses the laser interferential optical system. This method can get rid of influence of ametropia and lenticular defect. The retina can accept the interference-fringe straight, so it can determine the retinal resolving power. Its design and structure is rational, light and compact, it operates easy. Measuring result can accord with classics national "E" vision form.

Hardware Implementation of Approximate Reasoning Based on a Neural Network Model

92P60151A Beijing JISUANJI XUEBAO [CHINESE JOURNAL OF COMPUTERS] in Chinese Vol 15 No 1, Jan 92 pp 77-80

[Article by Zhang Zili [1728 5261 0500] of the Department of Computer Sciences, Southwest Normal University, Chongqing 630715: "A Hardware Implementation of Approximate Reasoning Based on a Neural Network Model"; MS received 31 Jan 90]

[Summary] A hardware implementation of L. A. Zadeh's fuzzy-logic-based approximate reasoning (AR) based on a neural network model is presented. Oriented toward rule-based expert systems with large knowledge bases and real-time requirements, the hardware implementation incorporates the DYL series of continuous-value (i.e., fuzzy) logic circuits [manufactured by the Chinese Academy of Sciences' Institute of Semiconductors; see JPRS-CST-90-027, 29 Oct 90 p 13], which can directly process analog and digital signals. These circuits have a basic element set of max and min gates as well as a "variable-window general-purpose J gate." The definition for this variable-window J gate is:

$$X_{ab} = 1,\ a \leq X \leq b,$$

$$X_{ab} = 0,\ \text{elsewhere},$$

where a, b, and X are continuous quantities belonging to some space.

The AR neural network model is shown schematically in Figure 1, the rule selection layer in Figure 2, the logic circuit diagram in Figure 3, and an analog quantity multiplier (AQM) in Figure 4.

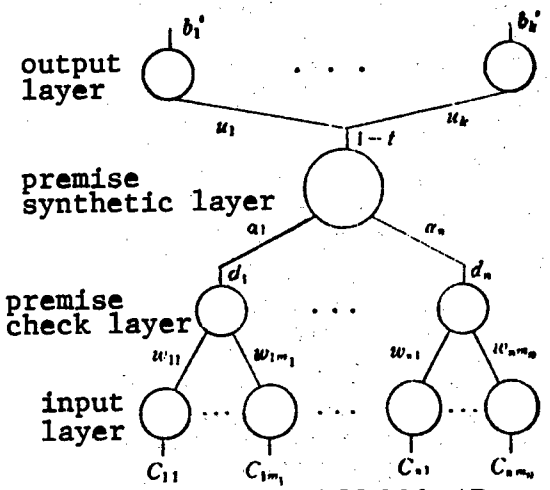

Figure 1. Neural Network Model for AR

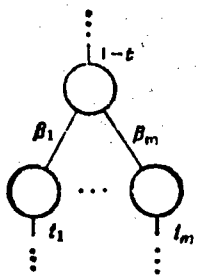

Figure 2. Rule Selection Layer

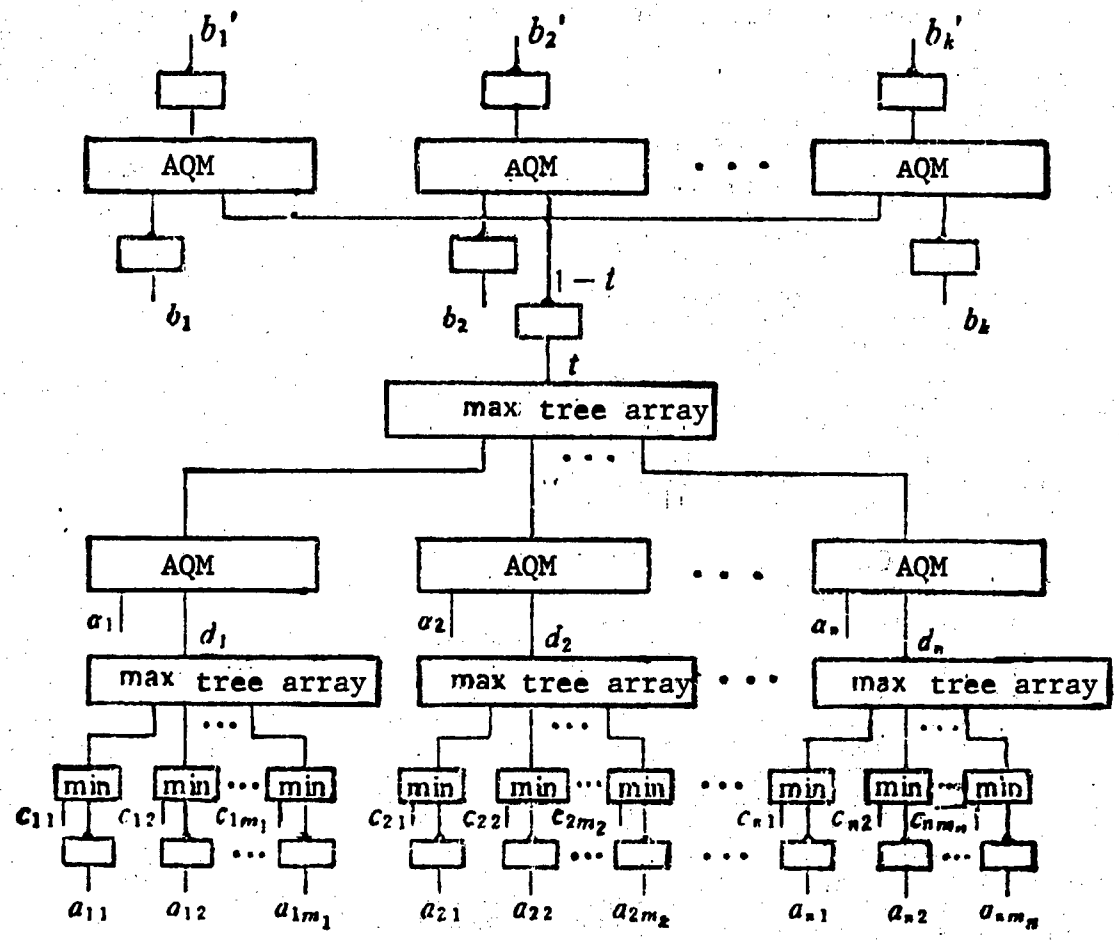

Figure 3. Logic Circuit Diagram Corresponding to Figure 1 (AQM = analog quantity multiplier)

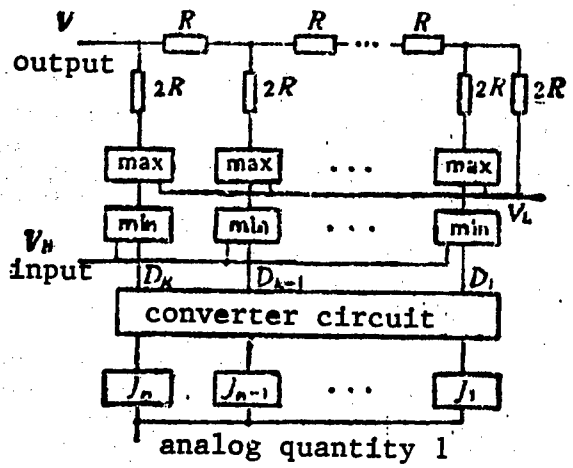

Figure 4. Schematic of AQM

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Computer Virus Simulation System Developed

92P60142A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 2, 8 Jan 92 p 2

[Article by Xiao Yan [2556 3601] and Chuan Ye [1557 7306]: "New Advance in Computer Virus Research"]

[Summary] The "computer virus simulation experiment system" developed by the CAS Computing Center passed the technical appraisal held on 14 December 1991 by the CAS Science and Technology Office. This system, which runs on a 286 or 386 PC and under the LAN link local area network operating environment, is designed to simulate the infiltration of viruses into computers with the MS-DOS or UNIX operating systems, and to be a tool for developing new anti-virus software programs. Targeted applications include research on virus mutations and viruses transmitted over networks, development of dynamic anti-virus programs, and training on information integrity and information safety.

NORINCO Completes Construction on ICA-LAN

92P60142B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 2, 8 Jan 92 p 60

[Article by Han Yun [7281 0061]: "North Industries Group Completes ICA-LAN Network"][Summary] To modernize its management, research, and production, the North Industries Group's Computer Applications Institute has built an ICA-LAN [inter-computer-adapter local area network] to interconnect computers—ranging from mainframes down to microcomputers—at its seven institutes in Beijing, including its information, systems, standardization, and new technology promotion institutes. The ICA-LAN, which passed technical appraisal on 29 November 1991, is a LAN based on an Ethernet-compatible NET/ONE networked system. It complies with Ethernet standards, with the XNS communications protocol, with the IEEE802.3 standard for network interfaces, and with the CSMA/CD (carrier sense multiple access with collision detection) network medium transmission control protocol. Transmission rate is 10 Mbps, and network topology incorporates the tree structure, permitting a maximum link-up of 1,024 workstations. Maximum inter-workstation range is 4,500 meters. The network includes both fiber optical cable and coaxial cable, a star coupler to link up to 27 Ethernet segments, and Ungermann-Bass MIU-190 network interface units. Special software has been installed to permit duplex file transmission between heterogeneous computers—the Siemens 7600, VAX8700, SUN, and IBM PC computers in the network all run under different operating systems.

Nanjing OSI MAN Completed

92P60142C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 3, 15 Jan 92 p 1

[Article by Gao Lihua [7559 7787 5478]: "Nanjing Metropolitan Area OSI Network Completed"]

[Summary] The Nanjing OSI [Open Systems Interconnection] computer metropolitan area network (MAN), or JSnet—five years and over 250 man-years in the making—was formally completed and passed Jiangsu Province technical appraisal on 26 December 1991. Jointly developed by over 10 high-tech units including Southeast University and the Jiangsu Province Computing Technology Institute, JSnet represents the first major domestic OSI software development project involving imported mid-sized and mainframe computers in a closed operating system. In terms of network engineering, protocol engineering, standardized technology, and OSI network implementation techniques, JSnet meets late eighties international standards. The entire system includes three communications sub-network nodes, a network control center, and three mainframe computers of different types. All of the protocol software is domestically copyrighted, and the X.25 communications controller, encryption devices, and other hardware equipment is all well known to domestic engineers. The foregoing represents the first phase of the Jiangsu Province Computer Network construction plan; the second phase (1992-1996) will cover MAN applications, improvements, and the construction of a provincial-area-network main trunkline, while the third phase (1996-2000) will realize the completion of the entire provincial-area computer network.

Fuzzy Intelligent Controller Developed at Changsha Institute

92P60142D Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 3, 15 Jan 92 p 2

[Article by Chang Sheng [2490 5110]: "Fuzzy Intelligent Controller Unveiled in Changsha"]

[Summary] Changsha Jiaotong Institute has developed a fuzzy intelligent controller—an all-parallel automatic control system with applications in the electric power, defense, chemical engineering, pharmaceutical, and similar industries. The new device controls a variety of variables, including temperature, pressure, flow, torque, velocity, voltage, and current. Designed upon the approximate inference principles of modern fuzzy set theory, this intelligent controller does not rely on a CPU and has no software "bottleneck," so that its control speed has reached the nanosecond level.

CIMS: A Milestone in Enterprise Development

92FE0219A Beijing JICHUANG [MACHINE TOOLS] in Chinese No 11, Nov 91 pp 13-15

[Article by Yi Weili [2496 3555 6849] of the Jinan First Machine Tools Plant: "CIMS: A Milestone in Enterprise Development"; (Part of a series "On Implementing a Chinese-Style CIMS")]

[Text] CIMS [computer integrated manufacturing system] technology was born in the mid-1970's and prospered in the 1980's. In China's "863 Project," CIMS was a high-tech target for China to catch up in the twentieth century and a foundation for China's industrial automation in the twenty-first century. To discuss the enterprise implementation of CIMS as an industrial technology, this author wishes to express some views based on the experience of the Jinan First Machine Tools Plant (JFMT).

I. CIMS Is a Milestone in Enterprise Development

JFMT is a major enterprise in China's machine tool industry and one of the main export bases for electrical machinery products. A pivotal point in the development history of JFMT was the Third Plenary Session of the Eleventh Party Central Committee. Before 1979, the technology level of JFMT for machine tool manufacturing was stalled at the 1950's and 1960's level. Under the stimulation of the Party's reform and openness policy, JFMT was the first in the industry to engage in foreign cooperation in production. JFMT entered a sell-back agreement with Mazak Corporation in Japan for Mazak machine tools. In the past 10 years, JFMT made great strides in importing, domestic cooperation, and technical reform. In the areas of production value, production quantity, profit, and foreign exchange, JFMT enjoyed an average annual growth rate of 30 percent in these economic indicators. These advances have raised the status of JFMT from a low-level enterprise to a level-1 national enterprise. How can JFMT continue its development? We feel that the next steps should be as follows:

1. It would be very difficult to raise the level of the original automation. Beginning in 1986, JFMT switched from importing manufacturing technology to importing management technology. To this end, we imported the OIR group technology software system and VAX computers and have engaged in computer assisted process planning (CAPP), computer-assisted financial/production management, and CAD using 3-D workstations. However, since the technology developed was a stand-alone technology unconnected to others, the role in enterprise management was not very prominent.

2. Compared to Mazak, JFMT had caught up with the technical level when the cooperation agreement was signed. However, the technical gap between Mazak and JFMT has widened again. In the last 10 years, development at JFMT was climbing at a 30° angle, but Mazak was climbing at an 80° angle. The contrast, shown in Tables 1 and 2, is shocking.

Table 1. Comparing JFMT and Mazak in Management Efficiency

Item	Mazak (man days)	JFMT (man days)	Difference (times)
Major goals in annual production	3	180	60
Measured annual production	1	105	105
Budgeted materials quota	0.5	30	60
General management	3	360	120
Cost and profit analysis	1	186	186
Materials and supply plan	3	180	60

Table 2. Comparing JFMT and Mazak in Production Efficiency

Component	Machine Bed		Main Shaft		Main Shaft Box	
Item:	Mazak	JFMT	Mazak	JFMT	Mazak	JFMT
Number of processes	5	12	11	22	4	14
Unit-hours (units)	13	55	5	35	6	17
Batches (units)	(arb.)	10	(arb.)	20	(arb.)	10
Production cycle (days)	6	80	10	70	4	50

In the 1970's the world entered the information age and the world market changed drastically. The traditional stable market has become a dynamic, variable market. Vicious competition between the enterprises moved society forward and created a harsh environment for enterprises to survive in. After a careful study and analysis of the differences in production value and labor productivity between Mazak and JFMT, we realized that the greatest differences were in data analysis and utilization in the three areas of management, engineering, and manufacturing. In other words, the greatest difference was in the computer integrated manufacturing (CIM) technology.

While we were studying how to catch up with Mazak and do better than Mazak, the expert group of the State's "863 Project" chose JFMT as a priority plant for China's CIMS.

II. CIMS Goals of JFMT

After JFMT became a priority plant for CIMS, experts helped and directed an analysis of the plant's current status based on the CIM concept. The study identified the major problem areas existing in the plant and repeatedly evaluated the production management goals of the plant. A strategic goal for the year 2000 was established. The goal is to make JFMT a high-tech, high-quality, efficient, advanced export-oriented enterprise for manufacturing numerically controlled (NC) machine tools. Table 3 shows the major targets for the Eighth 5-Year Plan and Ninth 5-Year Plan.

Table 3. Major Economic Targets for JFMT by the Year 2000

Item	Unit	1989	1995	2000
Total output	%	100	100.47	100.36
Total output value	%	100	260.49	499.08
Sales	%	100	224.80	402.63
Foreign exchange created	%	100	364.77	701.79
Profit	%	100	278.35	545.42

Based on the major economic targets listed above, an overall goal was established for JFMT, that is, to enter the world market armed with the CIM concept and support. The product development plan of JFMT for the year 2000 is to diversify products, to raise product quality, to meet the customer's needs, and to become export-oriented. Based on this product development plan, JFMT must make full use of information technology and work on the weak lines in its production. A practical, reliable, and economically beneficial CIMS should be established so that JFMT may provide quality NC machine tools and CIM components in a timely and economic fashion. The goal is to reach the early 1990's world standard by the end of the Ninth 5-year Plan.

Based on the overall goal in CIMS and the current status of the plant, we have also designed the following four applications systems and formulated the applied system goals. The systems are the Technical Information System (TIS), the Management Information System (MIS), the Manufacturing Automation System (MAS), and the Computer-Aided Quality Assurance (CAQ) System. In addition, we have also designed a Data Administration System (DAS) and a Network Support Environment (NSE) to facilitate the collection of data on a plant-wide level. A complete system of goals has therefore been established, from the development strategy to CIM and to the applied systems and support systems of CIMS. This complete goal system will specify our priority and direction for the next 10 years in our enterprise reform and development. The overall structure of the CIMS in JFMT has a staged structure and an open and distributed character, as shown in Figure 1 below.

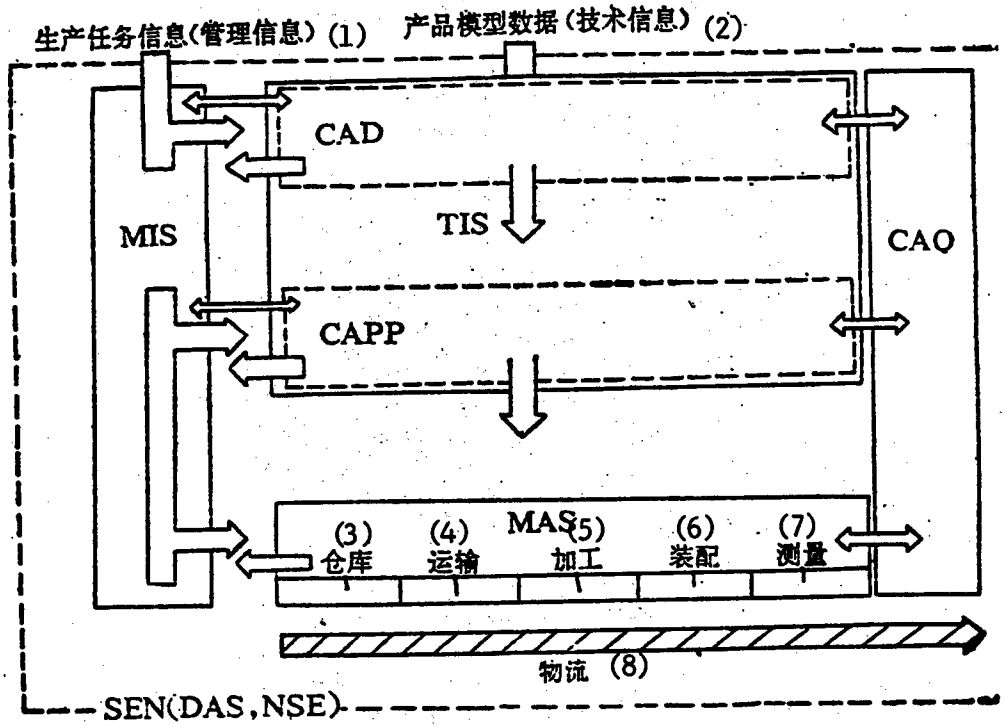

Figure 1. JFMT CIMS System Structure

Key: 1. Production information (management information); 2. Product model data (technical information); 3. Warehouse; 4. Transportation; 5. Machining; 6. Assembly; 7. Measurement; 8. Materials flow

III. Implementation Plan for JFMT CIMS

To match the Eighth and Ninth 5-Year Plans, the implementation of the JFMT CIMS will also be divided into two periods: phase-1 engineering will be in the Eighth 5-Year Plan, and phase-2 engineering will be in the Ninth 5-Year Plan. Since the Eighth 5-Year Plan requires more detailed planning, the phase-1 engineering is again divided into two stages: the first 3 years and the following 2 years. The missions of the first stage are as follows:

1. Build the JFMT CIMS computer development; complete the installation of the computers, build distributed autonomous data base system and networking between the three plant sizes (using hidden fiber optics).

2. Complete most of the management information system and put it into operation.

3. Complete the modularized design of machining centers, achieve CAE [computer aided engineering]/CAD in the main transmission of the machine tools, and achieve CAD/CAPP/NCP [numerical control programming] in the main shaft and disks.

4. Complete quasi-FMS of casing machining, DNC [direct numerical control] of main shaft, and GTC (group technology cell) of disks.

5. Achieve partial on-line inspection and automated data acquisition. Establish a preliminary quality control system for key parts.

6. Introduce and cultivate CIMS personnel, establish a team of CIMS workers in the young and middle-aged groups and solve the personnel integration problem.

The major tasks for the second stage are:

1. Put all management information systems in operation with the exception of the prediction and decision-making subsystems.

2. Achieve the integration of CAE/CAD of a whole machine design and CAPP/NCP artificial intervention.

3. Complete DNC and FMS of disks, establish a three-dimensional automated warehouse (10 rows, 32 columns, 16 layers, and 5120 compartments).

4. Enlarge the coverage of CAQ and achieve integration with other systems.

The major tasks of the phase-2 engineering will be adjusted after the completion of phase 1 of the project in the Eighth 5-Year Plan. The tentative plans are:

1. Complete CAD of large parts, CAPP of assembly, and CAE/CAD/CAT [computer aided test]/NCP integration of NC products.

2. Complete DNC of machine beds, pallets, and sheet-metal parts, achieve integration of MAS and other systems, improve MIS, CAQ and support environment, and thereby complete JFMT CIMS.

The total investment for the two phases of the project will be 113.50 million yuan and the investment recovery period will be 5.2 years. By concurrent investment and recovery, all the investment will be recovered by the year 2000.

Output Obtained From SG-1 FEL

92P60125A Chengdu QIANG JIGUANG YU LIZI SHU [HIGH POWER LASER AND PARTICLE BEAMS] in Chinese Vol 3 No 4, Nov 91 inside front cover

[Article by SFEL Team: "Shuguang-1 Free Electron Laser Facility Achieves Output"]

[Text] In order to conduct basic physical research into the free electron laser (FEL), the China Academy of Engineering Physics (CAEP) has designed and constructed the Shuguang-1 (SG-1) FEL facility (SFEL), which achieved output for the first time on 17 September 1991.

The SFEL electron-beam source is a 3.3 MeV induction linear accelerator (induction linac) with a beam intensity of 2 kA. In order to match the induction linac to the FEL interaction region, one needs to insert between the accelerator and the wiggler a collimator and three quadrupole devices, which form the beam modulation segment. The beam modulation segment or region has a total length of 9.5 m, and contains three current-detection assemblies used for on-line monitoring of the beam. The wiggler has the structure of an electromagnet, with a specially polished parabolic cylinder installed on the end face of the magnetic pole in order to better focus the two surfaces of the electron beam. An external view of the SFEL is shown in Figure 1.

The output signal is measured and recorded with an 8-mm wave detector diode and an HP 54502A oscilloscope. The detector diode is carefully installed into a metal cylinder to forestall space electromagnetic-wave interference. Figure 2 shows an experimentally measured typical signal waveform. To maintain the signal's frequency range, one needs to install between the detector diode and the receiving horn a bandpass filter with a special frequency range. Figure 3 shows the signal waveform after bandpass filtering. The bandpass filter parameters are: center frequency f = 35.5-36.5 GHz, insertion loss is about 2 dB, and out-band attenuation exceeds 20 dB.

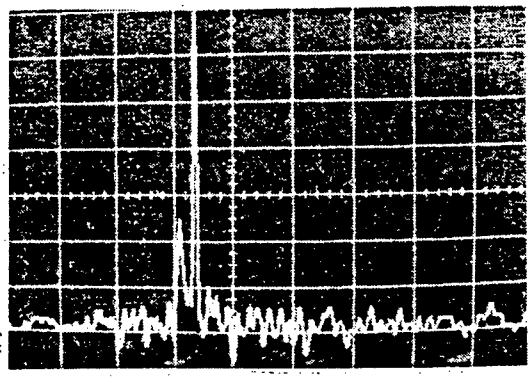

Figure 2. Typical Signal Waveform (vertical axis 100 mV/div, horizontal axis 100 ns/div)

The experimentally obtained power level and frequency range are in good agreement with the values predicted in a numerical simulation. The experiment's operating parameters and the aforementioned results are combined in Table 1.

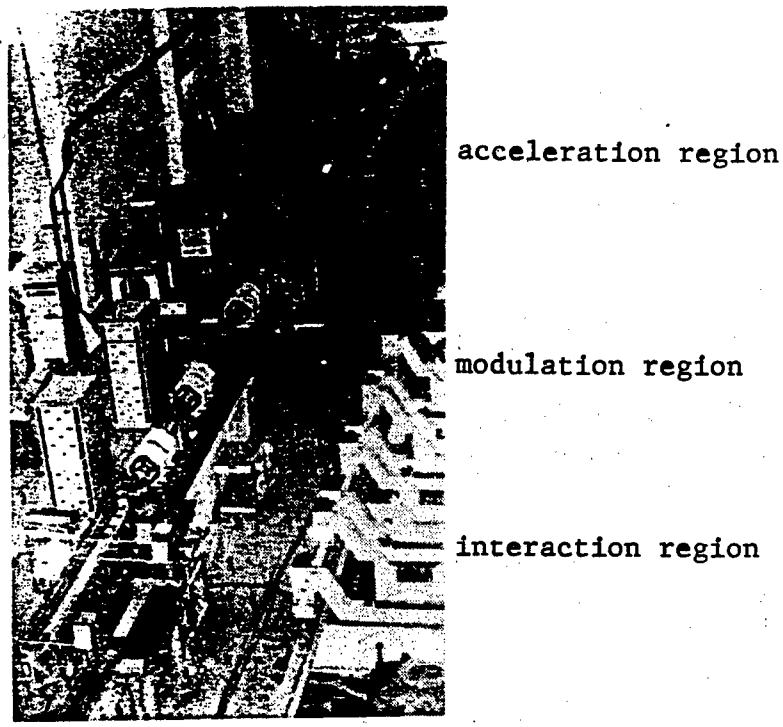

Figure 1. External View of SFEL

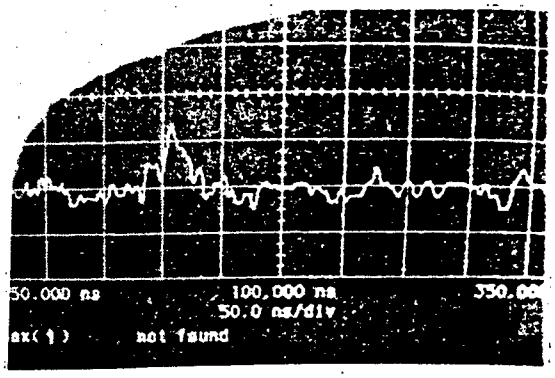

Figure 3. Waveform After Bandpass Filtering (vertical axis 100 mV/div, horizontal axis 50 ns/div)

Table 1. Experimental Operating Parameters and Initial Results

Electron beam	Wiggler	Waveguide	Output signal
$E_e \simeq 3$ MeV	$L_W = 2.64$ m	a x b = 9.8 x 2.9 cm	I = 50-150 A
I = 50-100 A	$\lambda_W = 11$ cm	wavemode = H_{01}	P_0 = 300-700 mW
$\varepsilon_n < 0.47\ \pi$ cm-rad	$B_W = 2.6$ kGs		f = 35.5-36.5 GHz
$\Delta E_e/E_e \simeq 4\%$	$\Delta B_W/B_W \simeq 0.7\%$		$\tau = 30$ ns
$\tau = 50$ ns	$\alpha = k_y/k_x = 2$		
	$\lambda_{out} = 1.5\ \lambda_W$		

Nation's First EMW-Pumped FEL Experimental System Completed

92P60152A Chengdu SICHUAN RIBAO in Chinese 6 Feb 92 p 1

[Article by SICHUAN RIBAO staff writer: "Nation's First 'Electromagnetic-Wave-Pumped Free Electron Laser Experimental System' Built in Sichuan"]

[Text] After a 4-year effort, a University of Electronic Science and Technology research group led by Profs. Liu Shenggang [0491 4141 4854] and Liang Zheng [2733 2973] and Associate Research Fellow Li Jiayin [2621 1367 5255] recently completed at the university the nation's first "electromagnetic-wave-pumped (EMW-pumped) free electron laser (FEL) experimental system." In the system, they used a 3-cm pumping wave and a 600-keV-energy electron beam to generate a 3-mm-band FEL. This type of tunable-frequency laser has important applications in biomedicine, materials science, and a number of cutting-edge research areas.

Ultra-Short-Pulse 100GW-Class Nd:Glass Laser Developed

Short Description

92P60143A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 20 Jan 92 p 1

[Article by Huang Xin [7806 6580]: "Ultra-Short-Pulse High Power Laser System Unveiled in Shanghai"]

[Summary] Led by noted scientist Xu Zhizhan, a research group from the CAS Shanghai Institute of Optics and Fine Mechanics (SIOFM) has developed a miniaturized tunable-pulse width ultra-short-pulse high power Nd:glass laser. According to a search of published international scientific literature, this is the first such system to be developed worldwide. Pulse width is tunable from 20 picoseconds (ps) to 2 nanoseconds. When operated at a 20 ps pulse width, this laser has an output energy of over 2 joules, a corresponding power exceeding 100 gigawatts (GW), and an 80 percent concentration of output laser energy within a 0.3-milliradian solid angle. The entire device occupies only 10 square meters of area. Developed as part of the state's "863" High-Tech Development Plan, this new high power laser was formally certified on 30 December 1991.

Detailed Description of 2.5J/20ps Laser

92FE0217A Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 11 No 11, Nov 91 pp 961-968

[Article by Xu Zhizhan [1776 5267 1455], Chen Shisheng [7115 2514 0524], Ouyang Bin [2962 7112 2430], Lu Haihe [7120 3189 7729], Lin Lihuang [2651 4409 3552], Li Shiying [2621 1102 5391], Wang Shijie [3169 0013 2638], Fan Liming [2868 4539 2494], Zhang Zhengquan [1728 2973 3123], Zhu Guoying [2612 0948 5391], and Peng Hui [1756 6450] of Shanghai Institute of Optics and Fine Mechanics (SIOFM) of the Chinese Academy of Sciences: "High Power Nd:Glass Laser With Output of 2.5J/20ps"; MS received 8 Mar 91, revised 7 May 91]

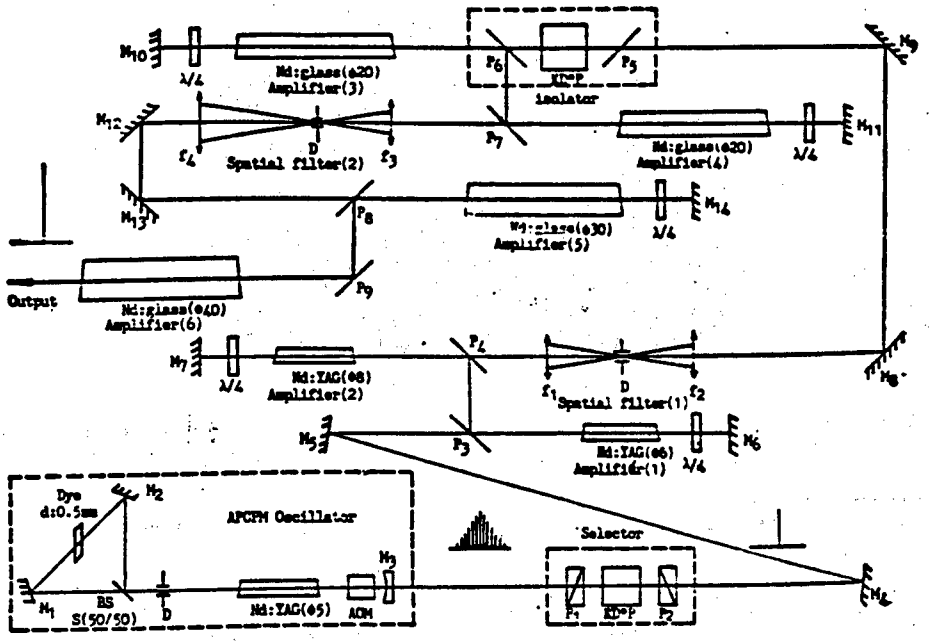

Figure 1. High Power Laser System Configuration

[Text]

Abstract

A high power ultrashort-pulse Nd:glass laser system with an output of 2.5 J in 20 ps and a beam divergence of 0.3 mrad covering 80 percent of its total energy is developed. The pulse width of this device is tunable from 20 ps to 2 ns.

I. Introduction

High power lasers have been used for studies on plasma interaction, nuclear fusion and X-ray lasers for many years. In recent years, the development of high-energy, high-brightness ultrashort lasers and the use of such devices to study the mutual interaction between ultrashort lasers and matter, multi-photon ionization at atomic threshold, super-strong field physics and the ultrashort-laser-pulse-pumped X-ray laser has received a great deal of attention worldwide.

In order to expedite the effort to study the interaction between ultrashort-pulse high power lasers with matter in China, and to provide a solid foundation for the 1 J/1 ps high-brightness ultrashort-pulse Nd:glass laser under development, a variable-pulse-width (20 ps-2 ns) ultrashort high power Nd:glass laser has been developed. At 20 ps, the output is greater than 2.5 J and the power is of the order of 10^{11} W [i.e., 100 GW].

This paper addresses the physical design and operating characteristics of the device.

II. System Description

Figure 1 shows the layout of the device. The device includes an active/passive colliding-pulse mode-locked (APCPM) Nd:YAG laser oscillator, a Pockels cell optoelectronic single pulse selector, a two-stage double-pass Nd:YAG preamplifier, a three-stage double-pass Nd:glass main amplifier, a single-stage 40-mm-diameter Nd:glass final-stage amplifier, a Pockels cell optoelectronic isolator and two vacuum spatial filters. The entire system is compact in structure and is mounted on two 5 m^2 shock-proof platforms.

1. Oscillator

The APCPM Nd:YAG laser oscillator[1] is also shown in Figure 1. The non-resonant ring consists of a pair of S-polarized semi-reflective beam splitters (BS) and two reflective mirrors (M_1 and M_2); a saturable absorber made of either pentamethylidyne dye or BDN dye and placed accurately at the center of the non-resonant ring; an acousto-optic modulator (AOM) with a modulating frequency of 50 MHz and frequency stability of 10^{-6} placed immediately next to the output mirror; an output mirror, M_3, with a transmittance of 45 percent and radius of curvature of 10 m, mounted on an adjustable stand with a displacement accuracy of 10 μm for precision adjustment of laser cavity length to match with two times the frequency of the AOM; and a Nd:YAG rod 5 mm in diameter and 80 mm in length.

The oscillator combines the advantages of colliding-pulse mode-locked (CPM)[2,3] lasers and active/passive mode-locked[4,5] lasers. Hence, it has high stability and ultrashort pulse width. In addition, the saturable absorber can be conveniently changed to cover a pulse width range from ps to ns to meet the needs of a variety of experiments. Its output characteristics are as follows:

When using pentamethylidyne-dichloroethane as the saturable absorber, the mode-locked pulse width ranges from

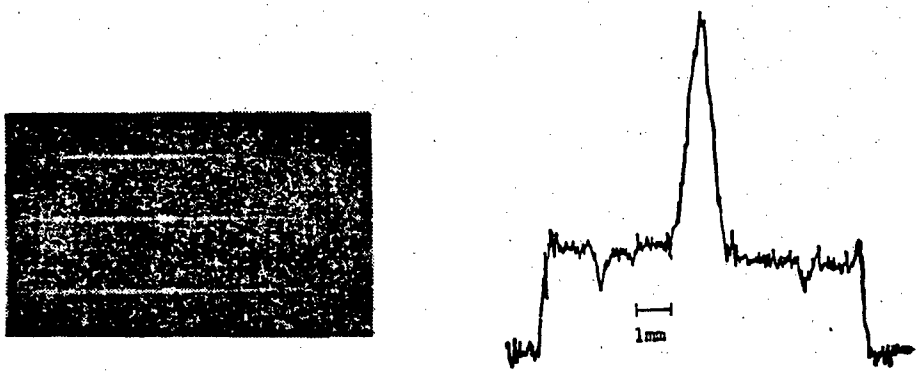

Figure 2. TPF Photograph of Pulses From the Oscillator With 20 ps Pulse Width and Its Density Trace

20 ps-50 ps depending on the concentration. The energy fluctuation between one train of pulses and another is less than +/- 4 percent. The energy of the train is approximately 1 mJ. Figure 2 shows the two-photon fluorescent picture of a 20-ps(FWHM)-wide pulse and its corresponding density trace. Figure 3 shows the shape of a 16-ps(FWHM)-wide single pulse which was measured with a streak camera after frequency doubling. When using BDN dye of various concentrations as the saturable absorber, the pulse width ranges from 200 ps to 1 ns. When using Cr:Nd:YAG crystal or LiF:F_2^- crystal as the saturable absorber, the corresponding pulse width is 1 ns to 2 ns. Figure 4 shows the traces of typical mode-locked pulses of four different absorbers measured with a streak camera.

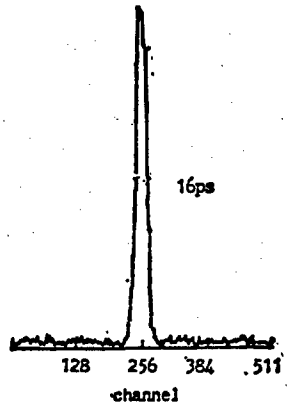

Figure 3. Pulse Shape of Single Pulse After Frequency Doubling Measured With a Streak Camera

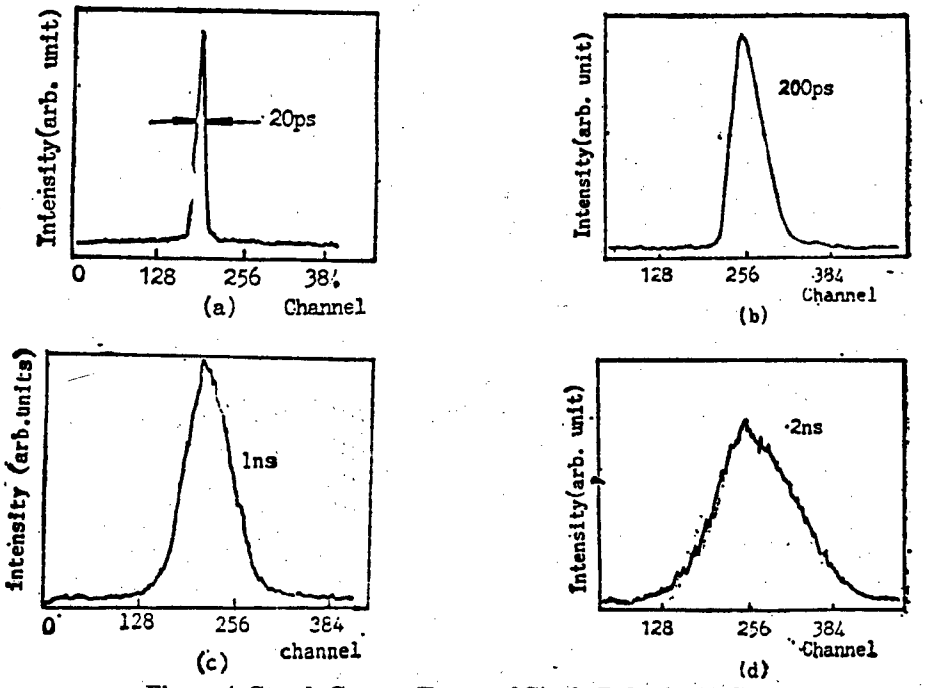

Figure 4. Streak Camera Traces of Single Pulse in APCPM

(a) Pulse width (FWHM) of 20 ps for pentamethylidyne-1.2 dichloroethane. (b) Pulse width (FWHM) of 200 ps for BDN film. (c) Pulse width (FWHM) of 1 ns for Cr:Nd:YAG crystal. (d) Pulse width (FWHM) of 2 ns for LiF:F_2^- color center crystal.

2. Single-Pulse Selector

A Pockels cell optoelectronic switch is used as a single-pulse selector. It is comprised of a pair of orthogonally polarized prisms P_1 and P_2 and a KD*P [potassium dideuterium phosphate] crystal. The laser pulse is used to synchronously trigger a high-voltage pulse to control the KD*P crystal to select a single pulse from a train of pulses. The mode-locked train of pulses is approximately 10 ns apart and the pulse width of the Pockels cell switch is 8 ns. Figure 5 [photo not reproduced] shows the pulse train and the single pulse selected.

3. The Amplifiers

The amplifier system consists of a Nd:YAG two-stage two-pass preamplifier (AM I, AM II), a three-stage Nd-doped silicate glass (Nd:glass) main amplifier (AM III, AM IV, AM V) and a single-stage 40-mm-diameter-aperture Nd:glass final-stage amplifier (AM VI). The energy of the single pulse selected from the train of pulses from the oscillator is approximately 0.1 mJ. To amplify it to over 2 J, the net gain of the amplifier system must be more than 10^4. The gain at each stage is shown in Table 1. In order to optimize the efficiency of these amplifiers to attain a higher net gain, a coaxial two-pass technique was used. After the first amplification stage, the beam is totally reflected by a quarter-wave plate and then passes another quarter-wave plate to turn the plane of polarization by 90°. After the second amplifier, the beam is coupled by two polarizers (P_3, P_4) before entering the next amplifier. The amplifier gain factor β of the system is given as follows:[6]

$$\beta = \{\ln[\exp(E_{out}/E_r) - 1] - \ln\{\exp[(E_{in}/E_r) - 1]\}/L, \quad (1)$$

where L is the length of the gain medium (2L for two-pass amplification), $E_r = h\nu/2\sigma S$ is the saturated energy density, S is the saturation coefficient and is 1.2, $\sigma = 1.2 \times 10^{-20}$ cm^2 (Nd:glass), $\sigma = 4.6 \times 10^{-19}$ cm^2 (Nd:YAG), and E_{out} and E_{in} are output and input energy density, respectively. E_{out} and E_{in} are experimentally determined to calculate the value of β for various stage amplifiers. Table 2 shows the gain of AM III at different optical pumping densities and input energy densities.

Table 1. Gain Arrangement

Name	Medium length (mm)	Gain	Output energy (mJ)	Energy density (mJ/cm^2)
Oscillator	Nd:YAG φ5 x 80		0.1	0.5
Pulse selector		50%	0.05	
Preamplifier I	Nd:YAG φ6 x 80	12	0.6	2
Preamplifier II	Nd:YAG φ8 x 80	12	7.2	14
Spatial filter		60%	4.2	
Isolator		60%	2.5	
Main amplifier III	Nd:glass φ20 x 500	10	25	8.3
Main amplifier IV	Nd:glass φ20 x 500	10	250	83
Spatial filter		70%	175	
Main amplifier V	Nd:glass φ30 x 500	6	1,050	150
Final amplifier VI	Nd:glass φ40 x 500	3	3.15 (J)	0.25 (J/cm^2)

Table 2. Measurement Gain of Two-Pass Amplifier (Nd:glass φ20 x 500 (mm))

Pump density J/cm^2	Input energy density mJ/cm^2	Output energy density mJ/cm^2	Gain β(cm^{-1})
0.17	2.76	14.4	0.019
0.22	2.76	18.8	0.021
0.29	1.76	34.0	0.028
0.17	2.44	14.0	0.020
0.22	2.44	21.2	0.024
0.29	2.44	28.0	0.027

4. Spatial Filter[7]

For a high power laser, the primary factor limiting its brightness is small-scale self-focusing. Use of spatial filters can eliminate spatial fluctuation of beam intensity, which subsequently suppresses self-focusing.

In an amplifier, spatial light intensity fluctuation due to non-linearity of the medium at various spatial frequencies can be expressed as:[8]

$$\left.\begin{aligned} \Delta I(K) &= I_0 \exp B(K), \\ B(K) &= \int_0^L g(K,x)dx, \\ g(K,x) &= K\left(\frac{\gamma I(x)}{n_0} - \frac{K^2}{4\pi n_0 k_0^2}\right)^{\frac{1}{2}}, \end{aligned}\right\} \qquad (2)$$

where $K = 2\pi/\Lambda$ is the spatial frequency, $\gamma = 4\pi n_2/n_o c$ (for Nd:glass the value of γ is 4.2×10^{-7} (GW/cm^2)), $I(x) = I_o e^{\beta x}$ and β is the gain. Figure 6 shows a series of B(K) (power density variable) as a function of wave number. The curves show the relation between the gain of laser intensity in an amplifying medium and its spatial frequency. The higher the frequency, the faster the intensity increases. Such different gain of intensity at different frequency is the cause of the non-uniformity of light intensity across a spatial cross section. It leads to small-scale self-focusing and destroys the directivity of the beam. Hence, it is necessary to use spatial filters to remove the fast-increasing high-frequency component to even out the light intensity across the beam in order to raise useful power that can be focused. The cutoff frequency of the spatial filter is $K_c = kd/2f$, where d is the diameter of a small aperture and f is the focal length of a converging lens. The system employs two spatial filters ($d_1 = 0.5$ mm, $f_1 = 500$ mm, $d_2 = 1$ mm, $f_2 = 1{,}000$ mm). Thus, K_c is 29.6 cm^{-1} and only spatial streaks with Λ greater than 2.1 mm are allowed to pass.

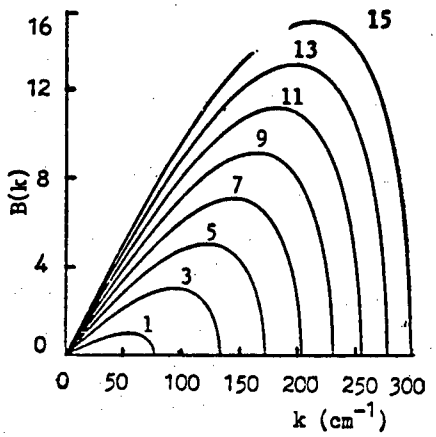

Figure 6. B(K) vs Wave Number

Figure 7 shows the far-field pattern of the output light after two filtering steps. There are no more fine spatial streaks and the intensity distribution is very uniform.

The transmittance of the spatial filter is:

$$T = 1 - \int_{K_o}^{K_{max}} 2\pi K I_0 \exp[B(K)]dK \qquad (3)$$

where K_{max} is the maximum spatial transmittance. Equation (3) indicates that the transmittance of a spatial filter falls as the B integral increases. In order to obtain uniform intensity light from an amplifier and to have a reasonable transmittance, B should be less than 5. The values of B for various amplifiers are calculated based on their gains. The results are shown in Figure 8. The sum of B for the system is 10.7.

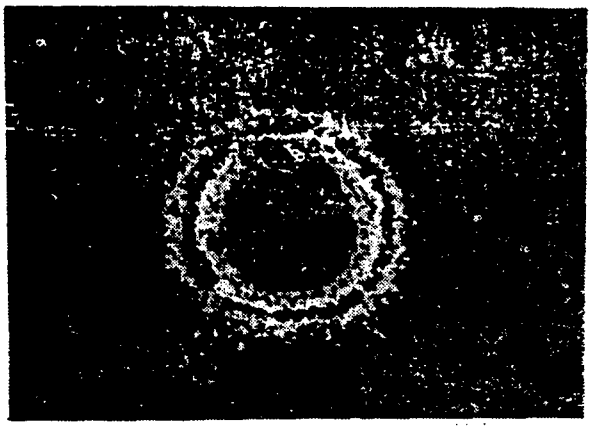

Figure 7. Far-Field Pattern of Final Amplifier Output Laser After Two Spatial Filters

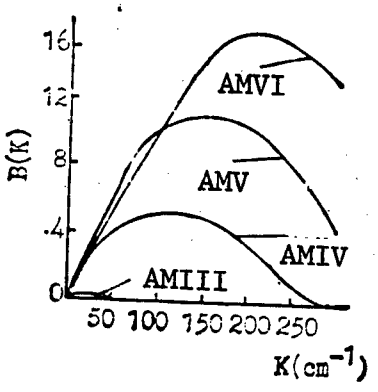

Figure 8. B(K) of Four-Stage Nd:Glass Amplifier vs Wave Number

5. Isolator

The optoelectronic isolator is a 20-mm-aperture KD*P crystal Pockels cell switch. Its high-voltage pulse is tripped by a laser pulse-triggered spark gap.

III. Output Characteristics

1. Operating Parameters

The operating parameters at various stages are shown in Table 3. Total energy output is 2.5 J - 3 J/20 ps, corresponding to a peak power of 10^{11} W.

Table 3. Operating Parameters

Parameters	OS	AM I	AM II	AM III	AM IV	AM V	AM VI
Light beam size (cm^2)	0.20	0.28	0.50	3.14	3.14	7.07	12.6
Gain $\beta(cm^{-1})$		0.17	0.12	0.028	0.038	0.032	0.039
Input energy (mJ)		0.03	0.47	1.97	20.0	138	850
Output energy (mJ)	0.07	0.47	5.40	20.0	199	850	2500
Input energy density (mJ/cm^2)		0.11	0.95	0.63	6.40	19.5	67.5
Output energy density (mJ/cm^2)	0.35	1.69	10.8	6.40	63.4	120	198.4
Output power density (GW/cm^2)	0.02	0.08	0.54	0.32	3.17	6.00	9.92
B*				0.40	2.70	3.60	4.00
Pulse width (ps)	20	20	20	20	20	20	20

* $\Sigma B = 10.7$

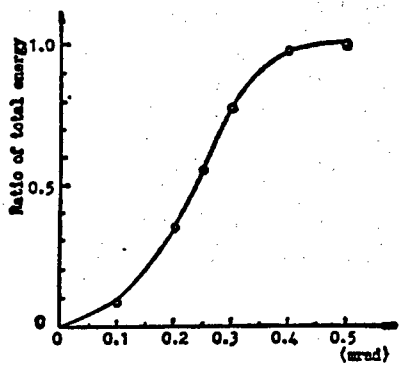

Figure 9. Final Amplifier Output Energy Distribution vs Divergence Angle

2. Far-Field Energy Distribution

The far-field energy distribution at the output end of the laser was measured with a wedge. The wedge used has a reflectance of R = 30 percent and the focal length of the lens is f = 2 m. When the energy of the laser at the last stage is 2.5 J and the energy density is 0.2 J/cm^2, 80 percent of the energy was found to be contained within 0.3 mrad, as shown in Figure 9.

IV. Conclusions

Variable pulse width ranging from 20 ps to 2 ns could be obtained using an APCPM Nd:YAG laser oscillator. This is the most convenient and effective way to produce variable-width pulses using a single oscillator. Experimentally, a single pulse was successfully selected from a train of mode-locked pulses and amplified using two-pass YAG amplification technology to result in a 5.4 mJ/20 ps, 1 Hz pulse. When this pulse was incorporated into a system consisting of Nd:glass laser amplifiers and spatial filters, a laser output at 2.5 J/20 ps with a divergence angle less than 0.3 mrad was achieved.

It is estimated that when the system operates at 1 ns the output will be 30 J/1 ns. It is a compact, pulse-width-tunable high power Nd:glass laser and will serve as a new tool for X-ray laser and plasma interaction studies.

The authors wish to thank Mang Yanping [5462 3601 5493] of the CAS SIOFM for providing the single-pulse switch and Zhu Qingchun [4555 1987 2504] for assisting in the laser pulse-width measurement.

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Low-Threshold 730 nm CSIS GaAlAs/GaAs Diode Laser

92P60159A Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 18 No 12, Dec 91 p 904

[Article by Bo Baoxue [5631 1032 1331], Ren Dacui [0117 1129 5050], and Zhang Xingde [1728 5281 1795] of the Second Institute, Changchun Academy of Optics & Fine Mechanics: "730 nm Low-Threshold Channel Substrate Inner Stripe GaAlAs/GaAs Laser"; MS received 26 Dec 90]

[Summary] Via a two-step liquid-phase epitaxy (LPE) technique, a 730-nm-wavelength channel substrate inner stripe (CSIS) GaAlAs/GaAs diode laser has been developed. Typical threshold current is 50 mA, linear optical power output exceeds 10 mW, and single-face differential quantum efficiency is 15 percent.

Structure of the device is as follows: onto the P-type GaAs substrate, a single P-type GaAs buffer layer and a single N-type GaAs current-confinement layer are grown via one-step LPE. Then, via standard optical lithography and wet chemical etching techniques, a 2-μm-wide V channel is etched out, followed by growth of a three-layer structure—a 0.8μm-thick P-type GaAlAs layer, a 0.3μm-thick active layer, and a 1.0μm-thick N-type GaAlAs layer—via two-step LPE. After thinning of the entire structure down to 80-100μm, the P-surface Au-Zn-Au and N-surface Au-Ge-Ni contacts are deposited. The wafers are then cleaved into chips with 150-250μm-long cavities. The Ag-Cu heat sinks are then soldered on, and the N-filled seals are made.

Green Light Output Obtained From Semiconductor-Laser-Pumped YAG Laser

92P60159B Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 18 No 12, Dec 91 p 928

[Article by He Huijuan [0149 1979 1227], Zhao Qingchun [6392 1987 2504], and Lu Yutian [7120 7183 3944] of the Laser Technology Open Laboratory, CAS Shanghai Institute of Optics & Fine Mechanics (SIOFM), and Fang Cujie [2455 4723 2212], Jin Zhiliang [6855 1807 5328] et al. of the Semiconductor Electronics Laboratory: "Green Light Output Obtained From Semiconductor Laser-Pumped YAG Laser"; MS received 29 Aug 91]

[Summary] SIOFM Laser Technology Open Research Laboratory scientists, employing the external-cavity semiconductor-laser-pumped Nd:YAG laser developed at SIOFM, achieved intra-cavity frequency doubling with a resultant green light output on 22 August 1991. The semiconductor laser source was a SIOFM-developed one-dimensional 10-element phase-locked array of GaAlAs/GaAs double-heterostructure lasers with a spatial integration power of 50 mW when operated in CW mode, and a spatial integration peak power of 100 mW when operated in pulse mode with a repetition frequency of 1 kHz and pulse width of 0.1 ms. The intra-cavity frequency doubler used a type-II phase-matched KTP crystal to produce the 532-nm-wavelength green output in both CW and pulse operating modes. In addition to a stabilized TEM_{00} mode, the apparatus can lase in the TEM_{mn} mode where m and n are variable from 0 to 7.

Double-Wavelength Nd:$YAlO_3$ CW & Pulsed Lasers, Other Research Achievements Pass Appraisal

92P60159C Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 18 No 12, Dec 91 p 942

[Article by Shen Hongyuan [3088 7703 0337] and Huang Chenghui [7806 0701 6540] of the CAS Fujian Institute of Material Structure: "Double-Wavelength Nd:$YAlO_3$ Continuous-Wave Laser and Pulsed Laser, Three Other Achievements Pass CAS-Level Appraisal in Beijing"; MS received 13 Aug 91]

[Summary] Four technical achievements of the CAS Fujian Institute of Material Structure—the development of a 1079.5nm/1341.4nm double-wavelength Nd:$YAlO_3$ CW and pulsed laser, a 1341.4 nm Nd:$YAlO_3$ high-power CW and high-energy pulsed laser, a high-power 1079.5 nm Nd:$YAlO_3$ CW laser, and a 1.66 μm Er:$YAlO_3$ pulsed laser—passed CAS-level technical appraisal on 4 July 1991 in Beijing. The double-wavelength Nd:$YAlO_3$ laser has a CW output power of 33.7 W at 1079.5 nm, a CW output power of 30.0 W at 1341.4 nm, a pulsed output energy of 1.39 J at 1079.5 nm, and a pulsed output energy of 3.71 J at 1341.4 nm. The 1341.4 nm Nd:$YAlO_3$ high-power CW laser has an experimentally measured output power of 188 W, while its high-energy pulsed variant has an output energy of 5.31 J. The 1079.5 nm Nd:$YAlO_3$ CW laser has an output power of 424 W and an efficiency of 2.54 percent. Finally, the 1.6549μm-wavelength Er:$YAlO_3$ pulsed laser has an output energy of 259 mJ. The appraisal committee evaluated the 1079.5 nm Nd:$YAlO_3$ high-power CW laser as matching advanced international standards and the other three lasers as being in the lead internationally.

High-Sensitivity Fiber Optic Weak Magnetic Field Sensor

92P60126A Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 11 No 12, Dec 91 pp 1120-1124

[Article by Cheng Yuqi [4453 3768 3825] and Zou Kun [6760 2492] of the Department of Electronic Engineering, Southeast University, Nanjing 210018: "High-Sensitivity Fiber Optic Weak-Magnetic-Field Sensor"; MS received 10 Dec 90, revised 28 Jan 91]

[Abstract] The development and construction of a fiber optic weak-magnetic-field sensor with a sensitivity (minimum measurable field) of 9×10^{-5} oersted is reported. The experimental apparatus (see Figure 4) employs a single-mode frequency-stabilized He-Ne gas laser with an output power of 2 mW and a wavelength of 632.8 nm, a magnetostrictive metal-glass transducer, and an alternating-current phase tracking (PTAC) homodyne phase detection

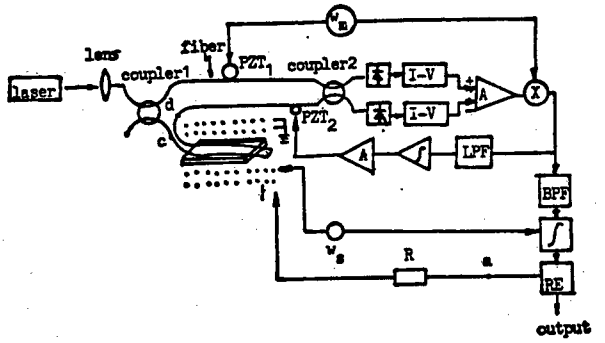

Figure 4. The Scheme of Weak-Magnetic-Field Optical Fiber Sensor With High Sensitivity; RE = rectification, A = amplifier, PZT = piezoelectric transducer, W_m = wattmeter, I-V = current/voltage meter, LPF = low-pass filter, BPF = bandpass filter

system in a Mach-Zehnder interferometer configuration. The nulling technique eliminates any problems arising from the magnetic hysteresis effects of the magnetostrictive material. The transducer theory and design method and the PTAC phase detection system are analyzed in detail.

Other figures show the metal-glass transducer, a model of a stripline transducer, a graph of the modulation index M vs thickness at various values of Young's modulus, two modes (open loop and closed loop using dc feedback nulling) of sensor operation,, sensor output with single-thickness transducer, a graph of the dc magnetic field measurement, and a graph of ac magnetic field measurement with double-thickness transducer.

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Experimental Investigation of Soft X-Ray Laser Saturated Gain in Ne-Like Ge Plasma

92P60126B Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 11 No 12, Dec 91 pp 1135-1136

[Article by Wang Shiji [3769 0013 4921], Gu Yuan [7357 2266] et al. of the Shanghai Laser Plasma Institute, Shanghai 201800, Chen Wannian [7115 8001 1628], Lin Zunqi [2651 1415 3825], and Fan Dianyuan [5400 3329 0337] of the High-Power Laser Physics Joint Laboratory (HPLPJL), CAS Shanghai Institute of Optics and Fine Mechanics (SIOFM), Shanghai 201800, and Zhang Guoping [1728 0948 1627], Sheng Jiatian [4141 1367 3944] et al. of the Beijing Institute of Applied Physics and Computational Mathematics, Beijing 100088: "Experimental Investigation of Saturated Gain in Neon-Like Germanium Plasma Soft X-Ray Laser"; MS received 9 Oct 91. See earlier brief report in JPRS-CST-92-004, 20 Feb 92 p 30]

[Summary] Following upon successful realization of Ne-like Ge soft X-ray laser output with a dual-target butt-joint configuration, a newly developed four-target cascade configuration with a total target length of 5.6 cm (each Ge target being 2 mm thick by 6 mm wide by 1.4 cm long) is employed to achieve Ne-like Ge soft X-ray laser near-saturated output at 19.6, 23.2, and 23.6 nm wavelengths. The experiment was carried out with HPLPJL's LF-12# facility, with a single-path output laser wavelength of 1.05 μm, a pulse width of about 1 ns, an on-target focal line length of about 30 mm, and width of about 120 μm, and a laser radiant intensity of 0.8-1.0 x 10^{13} W/cm^2. For the two higher wavelengths, the gain-length product GL was 17.3 and 16.7, respectively, while maximum intensity-to-length index was 2 x 10^8 photons/μm and 1.5 x 10^8 photons/μm, respectively.

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Gain Switching of Solid State Laser Pumped by Laser Diode Array

92FE0283B Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol 18 No 11, Nov 91 pp 806-810

[Article by Zhou Fuzheng [0719 1788 2973], Zheng Guizhen [6774 2710 3791], Sun Cuihua [1327 5050 5478], Shen Liqing [3088 7787 7230], and Fan Dianyuan [5400 3329 0337] of Shanghai Institute of Optics and Fine Mechanics (SIOFM), the Chinese Academy of Sciences (CAS): "Gain Switching of Solid State Laser Pumped by Laser Diode Array"; MS received 11 Jan 91. Project supported by Shanghai Natural Science Foundation. Tu Yuzhen [1458 3768 3791], Gu Deying [7357 1795 5391],

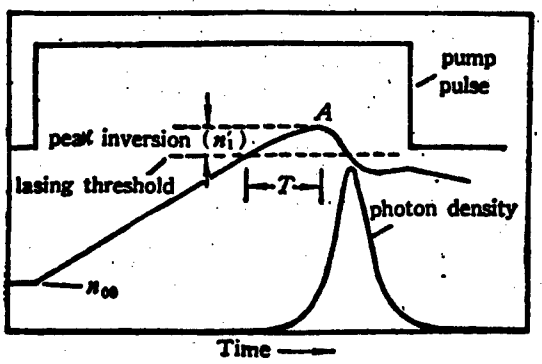

Figure 1. Principle of the Gain Switching

Jin Zhiliang [6855 1807 5328], Fang Zujie [2455 4371 2212], and Feng Weizhong [1409 0251 1813] also participated in the study.]

[Text]

Abstract

DPL [diode-pumped laser] gain switching of Nd:YAG solid state laser is realized by using a 100 mW laser diode array for pumping. Dynamic characteristics of gain switching are studied. A peak power of 80 mW at 1.06 μm is obtained, consistent with theoretical calculation. A novel three-step pumping scheme is proposed to further improve gain switching. A laser beam with peak power of 150 mW and pulse width of 0.2 μs is obtained.

I. Theory of Gain Switching

Gain switching (GS) is a novel fast-step-tube pulse driving technique to pump semiconductor lasers.[1-3] In recent years, this technique has been used to pump solid state lasers with laser diodes (LD); GS compresses the pulse width and improves output power.[4] The principle of GS is shown in Figure 1. A long low-intensity light pulse is first used to excite Nd ions to close to their lasing threshold. This is followed by superimposing a fast and narrow high-intensity step pulse to create an instantaneous population inversion situation. This sudden inversion produces the GS effect. It generates a single pulse with a higher amplitude and narrower pulse width compared to those for a normal relaxation oscillation. The output characteristics can be analyzed based on the Q-switching scheme.[5] Yet, different from Q-switching, the accumulation of high initial inverted particles is not due to cavity loss; instead, it relies on the fast pumping pulse. This is a simple and convenient method and produces an ideal high-power monochromatic light source.[6-8] Since the waveform of the pumping LD can be arbitrarily created based on the response of the driving current on the ns level to produce different GS effects, it is difficult to achieve the same results with xenon lamp pumping.

In order to obtain even higher output power and narrower and more stable laser pulses, a three-step pulse pumping scheme is presented. The second small step is used to adjust the LD intensity to keep it operating steadily at approximately the threshold level. Furthermore, it makes the third pulse even higher and narrower. This makes the LD operate at its output limit to produce an even larger number of inverted particles to result in a higher GS effect.

II. Experiment and Results

A 100-mW-output-power LD array with a center frequency of 809 nm is used. Its structure, the Nd:YAG solid state laser and the pumping setup are identical to the experimental arrangement used earlier.[9,10] The only difference is that the square-wave generator is replaced by a step-wave circuit. The effect of different step-wave forms on the output power and spectrum is investigated. The pulse width of the first step is T = 250 μs to match the fluorescent life of Nd ions (τ = 255 μs). The driving current is I = 1.1-1.3 I_{thLD}. First, the Nd:YAG solid state laser is excited by the pumping of the LD. Then, LD power is lowered to maintain the Nd:YAG laser at slightly below its threshold state. The pulse width of the second step is T = 10-20 μs. The leading and trailing edges are both less

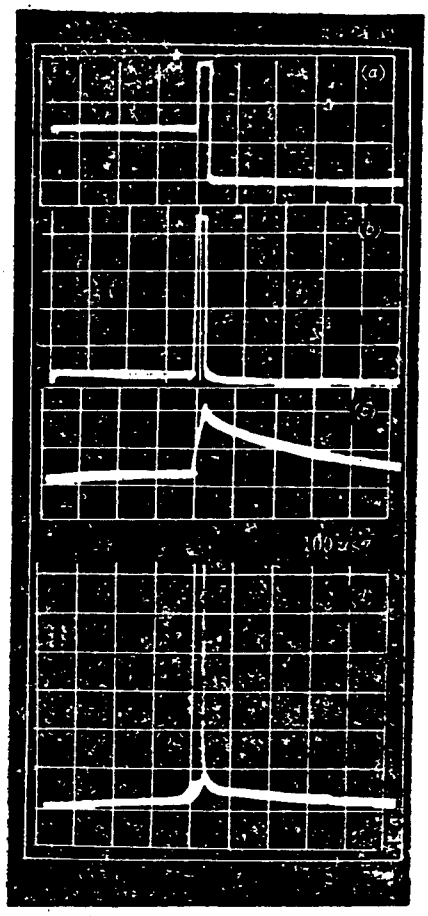

Figure 2. Temporal Profiles of GS-Nd:YAG Laser—(a) driving pulse; (b) LD array output; (c) Nd^+ fluorescence; (d) Nd:YAG laser output

than 1 μs. A large driving current I = 1.6-2 I_{thLD} produces a 150 mW peak output power from the LD array. This fast rate pumping creates an instantaneous, larger-than-threshold number of inverted Nd ions to result in GS. It produces a single narrow and high-power laser pulse. Figure 2 shows the driving pulse, LD output, Nd fluorescence and Nd:YAG output waveforms. The laser pulse width is 0.4 μs and the peak power is 80 mW. This is comparable to what others have obtained experimentally with similar devices (peak power of 60 mW).[4] Compared to the output of relaxation oscillation using LD pumping,[10] the pulse width is compressed by a factor of 5 and the amplitude is increased by a factor of 3; this means that the peak power is enhanced by a factor of 15.

Figure 3 shows output pulse width as a function of first-step pumping power. When pumping power is below the threshold of the solid state laser, the primary function of the second step is to pump Nd ions to reach the inversion threshold. The GS effect is very weak and the output pulse is wide. When the first-step pumping power is less or equal to the threshold, the second step is almost all for GS and the output pulse width is very narrow. When the first-step pumping power exceeds the threshold level, because the laser is already excited to emit light, it is impossible to create a very high initial population inversion. Hence, GS is also relatively weak and pulse width is relatively wide. Moreover, a secondary wave or even multiple waves may appear. When the first-step pumping power is fixed at less than or equal to the threshold, the power output versus second-step pumping power curve is as shown in Figure 4. When the second step is very low, the output power is also very small; it is only slightly higher than the peak relaxation oscillation power. As the second-step power

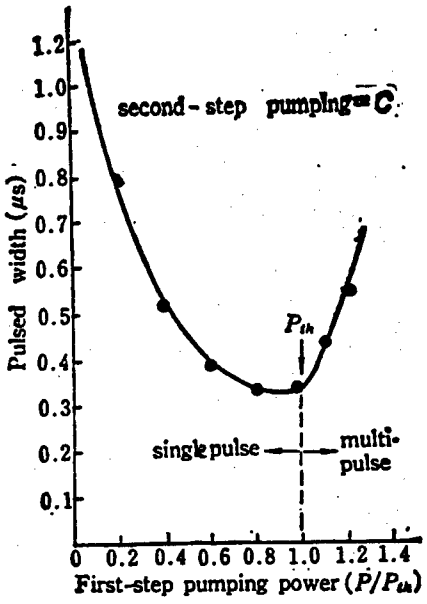

Figure 3. Pulse Width of GS-Laser vs the First-Step Pump Power

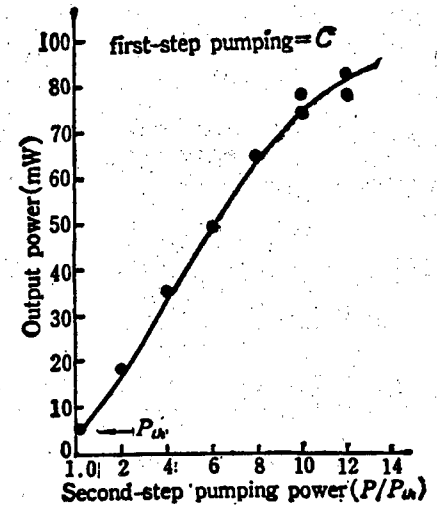

Figure 4. Output Power of GS-Laser vs the Second-Step Pump Power

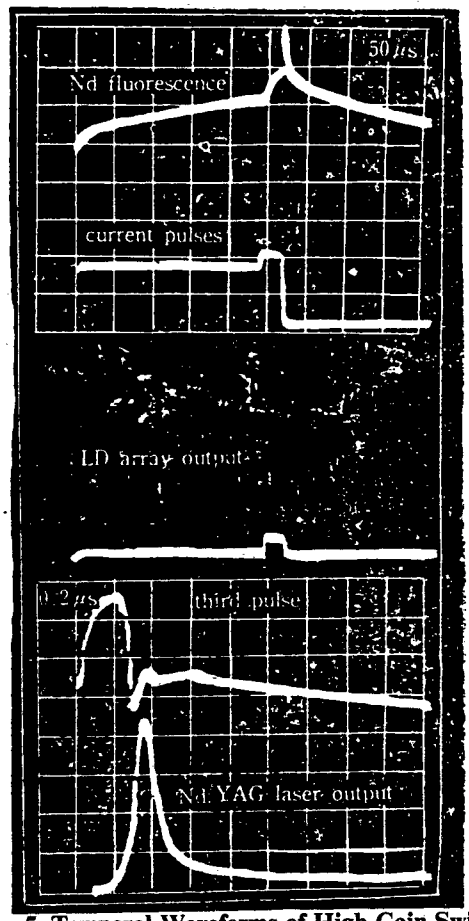

Figure 5. Temporal Waveforms of High Gain Switched Nd:YAG Laser

increases, the output power rises. However, at very high driving current, the LD waveform will be distorted and spectral drift occurs. The effective pumping power does not increase by much and the output power appears to be saturated. Furthermore, the LD ages rapidly until it fails.

In order to obtain even narrower and higher output, a high GS method is designed and tested. In the two-step pumping experiment discussed above, due to slight fluctuation of the voltage of the first long pulse and limitations in the temperature control accuracy of the LD cooler, the LD output varies slightly and its spectrum drifts somewhat. It is very difficult to reach a near threshold level at the instance the first pulse terminates. Thus, a portion of the energy of the second pulse is used to bring the solid state laser to its threshold and the remaining energy is for GS. This requires an even faster and higher pumping rate to produce the desired GS effect. However, a large driving current of a fixed pulse width will cause LD aging and failure. To this end, we studied the dynamic characteristics of GS in the LD itself. The relation between driving current and output power, pulse profile and emission spectrum of the LD was measured to determine the condition of use up to the point of failure. A three-step pumping current has been designed and developed.

The three-step pumping scheme adds a small driving pulse (I = 1.3-1.5 I_{thLD}, T = 5-20 μs) at the end of the first step to adjust its amplitude and density to precisely control the LD so that it stabilizes at the threshold of the Nd:YAG laser. It is followed by a high and narrow pulse (I = 3-5 I_{thLD}, T = 0.5-1.0 μs, $T_r < 0.001$ μs). This intense excitation pulse causes the output of the LD array to reach approximately 0.5 W, which is its limit, and produces a high-GS effect. Figure 5 shows the driving current waveform, LD lasing waveform, Nd fluorescence profile and instantaneous Nd:YAG solid state laser output from the third step. The laser pulse width is 0.14 μs and the peak power is 150 mW. Compared to normal relaxation oscillation, the pulse width is compressed by 8-10 times and amplitude is increased by 4 times. This means the peak power is enhanced by 30-40 times.

III. Theoretical Calculation

The DPL rate equation, photon number equation, calculated square-wave pumping threshold, relaxation oscillation output profile and peak power have been discussed in earlier work.[9,10] Here, only the effect of step pumping on DPL GS is discussed.

The temporal equation of state of the first step is:

$$\begin{cases} \dfrac{dx}{dt} = \dfrac{2P_1 f}{\pi h\nu_p L\omega_p^2 N_0}\exp(-u) - \dfrac{x}{\tau} - \dfrac{2N_0 C\sigma}{\pi\omega_0^2 n_d L}\exp(-a^2u)xy, & t \leqslant t_1 \\ \dfrac{dy}{dt} = \dfrac{N_0 C\sigma a^2}{n_d}\, y\int_0^\infty x\exp(-a^2u)du - \dfrac{C\sigma}{2n_d L}\, y + \dfrac{\Omega\omega_p^2 L}{8\tau}\int_0^\infty x\,du, & t \leqslant t_1 \\ x_{t=0} = 0 \\ y_{t=0} = 0 \end{cases}$$

The temporal equation of state of the second step is:

$$\begin{cases} \dfrac{dx}{dt} = \dfrac{2P_2 f}{\pi h\nu_p L\omega_0^2 N_0}\exp(-u) - \dfrac{x}{\tau} - \dfrac{2N_0 C\sigma}{\pi\omega_0^2 n_d L}\exp(-a^2u)xy, & t_1 < t < t_2 \\ \dfrac{dy}{dt} = \dfrac{N_0 C\sigma a^2}{n_d}\, y\int_0^\infty x\exp(-a^2u)du - \dfrac{C\delta}{2n_d L}\, y + \dfrac{\Omega\omega_p^2 L}{8\tau}\int_0^\infty x\,du, & t_1 < t < t_2 \\ x_{t=t_1} = x^0(u) \\ y_{t=t_1} = y^0(u) \end{cases}$$

where $x = N/N_0$, $y = \phi/N_0$,

$$a^2 = \omega_p^2/\omega_0^2,\ u = -2\tau^2/\omega_p^2$$

P_1 and P_2 are the first- and second-step pumping power, respectively, f is the pumping efficiency, $h\nu_p$ is the pumping photon energy, L is the cavity length of the monolithic solid state laser, ω_p is the waist of the pumping bean, ω_0 is the basic mode dimension of the solid state laser, N_0 is the excited ion density, N is the inverted

particle density, φ is the total number of photons in the cavity, δ is the two-pass loss, σ is the gain cross-section coefficient and τ is the fluorescent lifetime of the Nd ion. The first-step pumping time is $\Delta T_1 = t_1 - 0$ and the second-step pumping time is $\Delta T_2 = t_2 - t_1$. x^o and y^o are the end state of the first step and initial condition of the second step. The third step is noted similarly.

These differential equations are solved by using the Runge-Kutte method.[13] The calculated values of gain switching of a LD-pumped Nd:YAG laser are:

Two-step pumping:

peak output pulse power = 68 mW,

output pulse width = 320 ns (FWHM).

Three-step pumping:

peak output power = 113 mW,

output pulse width = 120 ns (FWHM).

Figure 6 shows the calculated profile of a gain-switched Nd:YAG laser pumped by steps. It is consistent with the experimental data. Further investigation will be carried out to study the kinetics of a multi-step LD-pulse-pumped solid state laser, limits of DPL GS and high-repetition-frequency DPL GS.

The authors wish to thank Li Yuanhe [2621 6678] and Chen Hao [7115 3185] for their participation in the experimental work, Lin Kangchun [2651 1660 2504] for providing guidance in the fabrication of the semiconductor cooler, Du Shigao [2629 0013 7559] for preparing high-quality anti-reflective and reflective coatings, and Hu Zhongliang [5170 0022 5328] for machining small laser rods.

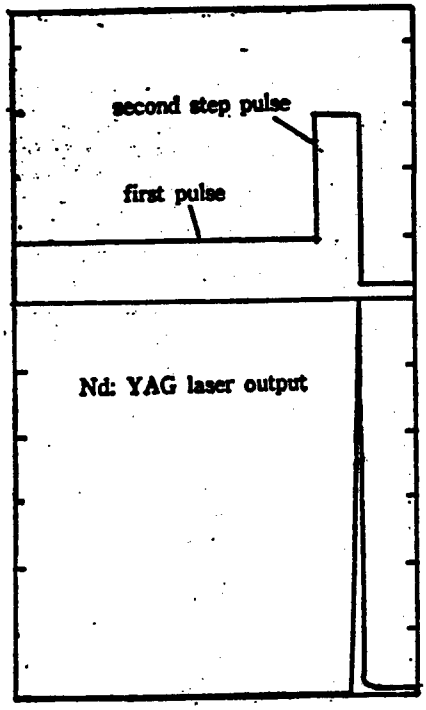

Figure 6. Calculated Profiles of GS-Nd:YAG Laser

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The Separation of Color Invariance and Highlight in Color Image (I)

92FE0217B Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 11 No 11, Nov 91 pp 1041-1045

[Article by Huang Yuming [7806 3768 2494] of Beijing Institute of Control Engineering, Ministry of Aerospace Industry, Xu Guangyou [1776 0342 0147] of the Computer Science Department, Qinghua University, and Ye Peijian [0763 1014 1696] of the Chinese Academy of Space Technology: "The Separation of Color Invariance and Highlight in Color Image (I)," funded by the National Natural Science Foundation; MS received 27 Aug 90, revised 4 Mar 91]

[Text]

Abstract

The chromaticity of an object surface scene is a constant feature irrelevant to its shape, a phenomenon called color invariance. Nevertheless, due to highlight and shading, the color in an image is variable. The correct way to understand image color is to establish a physical model for color reflection. This paper describes a method to calculate illuminant and object chromaticity coordinates based on the dichromatic reflection model proposed by Klinker.[1] It involves the plane fitting of a 3-D color histogram using the K-L transform to separate the interface reflection

component and the body reflection component. The limitation of a CCD camera is also discussed and some experimental results are presented.

I. Dichromatic Reflection Model

When light is projected on a dielectric material, such as a plastic, a portion of the light is directly reflected by the object according to Fresnel's law. Usually, the chromaticity of the reflected light is identical to that of the incident light. The remaining incident light enters the object and is scattered or absorbed by the object at certain bands before leaving the object. The chromaticity of the transmitted light is determined by the color of the illuminant and the reflection characteristics of the object. The reflection at the surface of the object is called "interface reflection," "specular reflection," "highlight," or "gloss." The reflection process inside the body is called "body reflection," "diffuse reflection," or "matte color."

The dichromatic reflection model considers that the spectral radiation at any point in a scene, $L(\lambda, i, e, g)$ is the sum of a reflection component $L_i(\lambda, i, e, g)$ and a body reflection component $L_b(\lambda, i, e, g)$, where λ is the light wavelength, i is the angle of incidence, e is the angle of emergence, and g is the phase angle. Assuming that surface orientation has no bearing on the illumination and reflection characteristics of the object (i.e., mutual reflection of body surface is not taken into consideration), then each reflection component is decomposed into a spectrum factor $c(\lambda)$, which represents chromaticity, and a geometric factor m(i, e, g), which represents geometric factors (determining the color brightness components). We have

$$L(\lambda, i, e, g) = L_i(\lambda, i, e, g) + L_b(\lambda, i, e, g), \quad (1)$$

$$\left.\begin{aligned} L_i(\lambda, i, e, g) &= m_i(i, e, g)c_i(\lambda), \\ L_b(\lambda, i, e, g) &= m_b(i, e, g)c_b(\lambda), \end{aligned}\right\} \quad (2)$$

A color camera uses the three primary colors to express the spectrum of the incident light of the scene. In the imaging process, the camera converts the continuous spectrum of the image projected onto the target plane at pixel position (x, y) into a color point <r, g, b> in the space of three primary colors. In other words, the color at point (x, y) in the picture c(x, y) = <r, g, b>. This is equivalent to the weighted sum of light intensities at various wavelengths. The weight is determined by the transmittance of the corresponding filter (red, green, blue) and other light-sensitive characteristics of the camera. The color image c(x, y) at a certain point can be expressed as a linear combination of the interface reflection component c_i and body reflection component c_b. The coefficients $m_i(i, e, g)$ and $m_b(i, e, g)$ are determined by the geometric factors corresponding to the point in the scene, i.e.,

$$c(x, y) = m_i(i, e, g)c_i(\lambda) + m_b(i, e, g)c_b(\lambda), \quad (3)$$

where $c_i(\lambda)$, a constant over the entire picture, is determined by the chromaticity of the single illuminant; $c_b(\lambda)$ is a constant for each monochromatic object and is determined by the chromaticity of the object in the scene. When limiting equation (3) to each monochromatic body in the picture, c_i and c_b are constants and m_i and m_b are variables. Based on the dichromatic reflection model, determining the chromaticity of the illuminant and object from a color picture can be considered as decomposing the interface reflection component c_i and body reflection component c_b from c(x, y).

In order to describe and study the color distribution using the dichromatic reflection model, a 3-D color histogram is established with each dimension corresponding to a primary color RGB. A 3-D point not only corresponds to a color (vector) but also represents the pixel frequency of that color in the picture. A 3-D histogram is a three-dimensional color space where each 3-D point has an assigned frequency number. Nevertheless, both interface reflection component c_i and body reflection component c_b correspond to a vector cluster in the 3-D color histogram. If $c_i = <r_i, g_i, b_i>$, then c_i in the 3-D histogram's corresponding vector cluster is given by $kc_i = <kr_i, kg_i, kb_i>$, where k is a non-zero real number. In the preceding text, it was pointed out that c_i and c_b both are the chromaticity of the color, i.e., the color's chroma coordinate. We arrange that, for chromaticity $c_i = <r_i, g_i, b_i>$, we have $r_i^2 + g_i^2 + b_i^2 = 1$ (refer to Section IV). For any color point (vector) <r, g, b> in the 3-D color histogram, its chromaticity is <nr, ng, nb> where $n = 1/\mathrm{sqrt}(r^2 + g^2 + b^2)$. Hence, any vector in the vector cluster kc_i has the same chromaticity, but different color (because of different brightness). In addition, this vector cluster contains all the vectors of the same chromaticity in the 3-D color histogram. Based on the dichromatic reflection model, the color distribution of the image of a monochromatic object (with chromaticity c_b) using a single illuminant (with chromaticity c_i) should be located in the dichromatic plane determined by vectors c_i and c_b.

II. K-L Transform and Plane Fitting

Based on the dichromatic reflection model, after forming an image of a monochromatic object (with chromaticity c_b) using a single illuminant (with chromaticity c_i) in a color camera, the color pixel set [unordered set:] c(x, y) at different points on the object corresponds to a point set in the 3-D color histogram. This set should be on a plane determined by vectors c_i and c_b. If two (or more) monochromatic objects (of different chromaticities) form images under the same illuminant, and the dichromatic plane determined by the pixel color distribution of each object can be found, then the chromaticity of the intersect vector of the two planes is the chromaticity of the illuminant. (Since c_i and c_b are vectors passing the origin, the plane defined by them also passes the origin and the intersect of the planes also passes the origin.)

Due to measurement error and noise, the color set [unordered set:] c(x, y) of the picture of an actual object is not distributed on the ideal plane in the 3-D color histogram. Instead, it is distributed over a wider area. This presents some difficulty in plane fitting. In this work, K-L transform is carried out as a pre-treatment. K-L transform is

also known as main-element transform. Here, we want to determine the maximum and minimum direction of color change. The minimum direction of color change is the normal direction of the dichromatic plane defined by vectors c_i and c_b Finally, a point is chosen as one point on the fitting plane (in this work it is the center of mass of the color set) to obtain the fitting plane equation:

$$Ax + By + Cz + D = 0 \qquad (4)$$

Then, the distribution of the color set around the fitting plane is examined to calculate the mean distance and maximum distance between the point set and the fitting plane to determine whether we should perform another K-L transform and the number of transforms required. When performing multiple K-L transforms, the distance threshold is given and new K-L transform and plane fitting are only carried out for points at a distance less than the threshold distance away from the fitting plane. According to the dichromatic model, D should be 0. However, because of noise and the non-linear relation between intensity and gray scale of the color camera, D usually has a large absolute value (of the order of 10). This also indicates that there is a substantial error between the fitting plane and the dichromatic plane. On one hand, the K-L transform and plane-fitting procedure can be used several times to avoid the participation of noise color points. On the other hand, the non-linear relation between intensity and gray scale and the pattern of noise generation (to be published later) have been experimentally determined. The linear relation between intensity and gray scale has been restored and the noise eliminated to lower the absolute value of D to below 5.

III. Practical Camera Model

The dichromatic reflection model and camera model are integrated by taking the limitation of the camera imaging process into consideration. The following is a discussion on how the characteristics of the CCD camera affect the pixel value in a picture.

Color clipping: In reality, the camera can only sense the spectral intensity of incident light over a finite dynamic range. Hence, analysis is done in a color cube. If the incident light is too intense at a particular pixel position, the camera can no longer sense and reflect this light. Therefore, the light measurement is clipped at one or more bands.

Blooming: In a CCD camera, when the incident light is too intense at a point on the target, not only the sensors at that location are fully saturated but also the stored charge diffuses toward neighboring pixels to increase their values. The affected pixels are called blooming pixels.

Color balancing: The common CCD camera is more sensitive to the red than the blue light. Furthermore, the effect of infrared on picture color is not removed. A light blue infrared cutoff glass filter may be used to eliminate the infrared effect and to lower its sensitivity in the red.

Gamma (γ) correction: The color pixel value is a function of the camera's response to the incident light. Due to gamma correction and some other transformation (such as color compensation) inside the camera, the output of the camera is not linear with respect to the incident light intensity. This kind of non-linearity causes the bending of color in air and destroys the very basis for using the dichromatic reflection model. The intensity-gray scale relation can be experimentally determined and the color pixel value can be changed to restore a linear relationship.

Chromatic aberration: Because the index of refraction of glass is a function of wavelength, chromatic aberration takes place in the imaging process. For a given focal length, the image of a certain band is focused well. The results of the other two bands are less perfect. Chromatic aberration has a larger impact on the pixels around the edge of a picture. It is dependent upon the quality of the lens.

IV. Experimental Results and Discussion

According to the terminology in chromatics, the chromatic coordinate (chromaticity) of a certain color is a normalized value consisting of three stimulations (arithmetic sum normalized). If the three stimulations of a given point are r, g and b, then the chromatic coordinate is $R = r(r + g + b)^{-1}$, $G = g(r + g + b)^{-1}$ and $B = b(r + g + b)^{-1}$. In this work, the chromatic coordinate used is somewhat different. The normalization here is done with respect to the geometric distance (sum of squares normalized). If the three stimulations of a given point are r, g and b, then its chromatic coordinate is

$$R = r/\mathrm{sqrt}(r^2 + g^2 + b^2),\ G = g/\mathrm{sqrt}(r^2 + g^2 + b^2),\ B = b/\mathrm{sqrt}(r^2 + g^2 + b^2) \qquad (5)$$

On one hand, this new definition is consistent with the normalization in the K-L transform. On the other hand, this definition was used in references 2, 3 and it is easier to compare results. (Obviously, it is easy to transform between the definition used and the standard definition.) In this work, we did not consider the standardization of color. The three primary colors and the color space are the original three primary colors and color space in the IMAG image system. For color comparison with other image systems, the color coordinate system must be transformed to the standard CIE color coordinates (to be discussed in a separate paper).

The experimental apparatus includes: a PUNIX-TMC56R color CCD camera and an IMAG color image-processing workstation equipped with the three true color image-processing plates manufactured by Data Translation Corporation, DT2858, DT2869 and DT2871, and a SUN386i workstation color monitor. The laboratory is light-tight. A projector is used to produce a white light. Different colors are obtained by using filters. A standard white plate (light source A at 10° viewing angle has chromaticity $x = 0.4525$, $y = 0.4074$) provided by the Optical Laboratory of the Chinese Institute of Metrology was used to measure the chromatic coordinates of white light and other colors.

Limited by the length of the text, only three experimental results are given. The work involved white, yellow and green light and three objects: light blue plastic cup, light yellow plastic vase and red plastic cup. Their chromatic coordinates were measured as follows: white light <0.59,

0.55, 0.60>, yellow light <0.69, 0.68, 0.25>, green light <0.14, 0.98, 0.14>, blue cup <0.43, 0.53, 0.73>, yellow plastic vase <0.64, 0.61, 0.47> and red plastic cup <0.96, 0.19, 0.18>. Experimentally, the object must be segmented as an algorithm of input.

Experiment 1: Find the chromaticity of the light source.

Input: Figure 1 (color inserts No. 1-3 in back cover [not reproduced]) shows the segmented pictures of the blue cup and yellow vase under white light.

Output: Chromaticity of the white light is <0.62, 0.53, 0.58>.

Experiment 2: Find the chromaticity of the light source.

Input: Figure 2 (color inserts No. 4-6 [not reproduced]) shows the segmented pictures of the blue cup and yellow vase under yellow light.

Output: The chromaticity of the yellow light is <0.65, 0.73, 0.18>.

Experiment 3: Find the chromaticity of the object.

Input: Figure 3 (color inserts No. 7-9 [not reproduced]) shows the segmented pictures of the red cup under white and yellow light.

Output: The chromaticity of the red cup is <0.96, 0.20, 0.18>.

It was found that if the difference in chromaticity between the illuminant and the object is small (the angle between the illuminant chromaticity vector c_i and object chromaticity vector c_b is small in the 3-D color histogram), the fitting plane formed by the segmented picture is unstable and is more susceptible to noise effect. Although theoretically two different vectors can define a plane, in reality, the larger the angle in between (< 90°) the more stable the plane defined by the two vectors is. Therefore, if the chromaticity of the illuminant is very very different from that of the object, the calculation becomes less accurate.

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The Separation of Color Invariance and Highlight in Color Image (II)

92FE0217C Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 11 No 11, Nov 91 pp 1046-1048

[Article by Huang Yuming [7806 3768 2494] of Beijing Institute of Control Engineering, Ministry of Aerospace Industry, Xu Guangyou [1776 0342 0147] of Computer Science Department, Qinghua University, and Ye Peijian [0763 1014 1696] of the Chinese Academy of Space Technology: "The Separation of Color Invariance and Highlight in Color Image (II)," funded by the National Natural Science Foundation; MS received 27 Aug 90, revised 4 Mar 91]

[Text]

Abstract

Image of objects in a camera is affected by the position and chromaticity of the illuminant. Due to the presence of highlight and shadow, ideal segmentation cannot be obtained by conventional algorithm. In this paper, the image is separated into two intrinsic images, i.e., matte image and highlight image, based on the dichromatic reflection model. The matte image is the original image with the effect of highlight removed. It reflects the invariance of the object itself and is not affected by external factors (such as the position and chromaticity of the illuminant). The highlight image is an image with highlight only. It reflects the influence of external factors and provides information about the scene.

I. Method for Separating Intrinsic Images

1. Problems Associated With Separation of Color Images

Usually, better results can be obtained by separating color images than monochromatic images. However, this process is often affected by highlight. Because the color in the highlight region is seriously affected by the position and chromaticity of the illuminant, the gray scale fluctuates dynamically. Figures 1(a), 1(b) and 1(c) (color inserts No. 10-12 [not reproduced]) show how the gray scales of r, g, and b vary from a non-highlight region to a highlight region and then back to a non-highlight region. The horizontal axes represent the position of the pixel and the vertical axes represent the gray scale values of r, g and b, respectively. In order to minimize noise, the average gray scale of several pixels with the same illuminance is obtained.

The color image captured by the camera is directly separated. The object with highlight is segmented into many regions. This is because a highlight interface is more apparent than an interface between objects. This means that the rate of change is even larger. Based on the dichromatic reflection model, the effect of highlight can be essentially eliminated after extracting the intrinsic images. Intrinsic images include a matte image and a highlight image. The matte image is an image with highlights removed. It reflects the invariance of the scene and is not affected by external factors. The highlight image is an image with highlights only, which happens to reflect the influence of external factors. In the matte image, the interface between the highlight region and non-highlight region is essentially removed. However, the interface between objects still remains. Hence, more ideal results can be expected if we segment the matte image, rather than the original image. Furthermore, the highlight image also provides information about the shape of the object.

12. Classification of Color Image Pixels

According to the dichromatic reflection model and camera model, image pixels may be classified into matte pixel, highlight pixel and clipped pixel.

A matte pixel is a pixel in the line of sight which only contains the body reflection component. The chromaticity of such a pixel is solely determined by the chromaticity of body reflection. Its intensity is dependent upon the normal direction of the corresponding scene point, viewing angle and incident angle. All matte pixels of a monochromatic object form a straight line in the 3-D color histogram, originating from the origin. The line's direction is the body chromaticity vector c_b. Due to diffusion by fine particles on the surface of the object, matte pixels may contain some reflection component. However, it can be neglected.

A highlight pixel is a pixel in the line of sight which contains body reflection component as well as interface reflection component. The highlight pixels on a line with equal body reflection show the variation of interface reflection only. The color set of these pixels forms a highlight line in the 3-D color histogram. The line starts at mbh of the body chromaticity line, where mbh is the body reflection component of these highlight pixels. The direction of the highlight line is the direction of the interface reflection vector c_i. Since the interface reflection component of a highlight pixel varies dynamically in the highlight region and the body reflection component varies gradually, the pixels in the highlight region appear in a skewed wedge shape in the dichromatic plane. A complex object may have many highlights. Then, the 3-D color histogram of the object looks like a comb. The handle of the comb corresponds to the entire family of matte pixels and each tooth corresponds to an individual highlight pixel family.

A clipped pixel is a highlight pixel outside the dynamic range of the camera in one or more bands. In the 3-D color histogram, it appears as the highlight pixel family bends at an angle at the color cubic interface. Clipped pixels are lost information at certain positions in an image because the camera has a finite dynamic range. Using the algorithm in this paper to extract intrinsic images, we discovered a number of black and white spots which correspond to clipped pixels in the original picture.

3. Vector Decomposition

Vector decomposition means expressing a vector as a linear combination of a set of basic vectors. The vectors of interest are three-dimensional color vectors in the 3-D color histogram. Assuming that vectors A and B are not colinear, then any vector C on the plane defined by vectors A and B can be expressed as:

$$C = KA + LB. \qquad (1)$$

Once A, B and C are given, it is easy to obtain K and L (where "·" represents the dot product of vectors):

$$\left.\begin{aligned} K &= [(A\cdot B)(B\cdot C)-(A\cdot C)(B\cdot B)]/ \\ &\quad [(A\cdot B)(A\cdot B)-(A\cdot A)(B\cdot B)], \\ L &= [(A\cdot B)(A\cdot C)-(A\cdot A)(B\cdot C)]/ \\ &\quad [(A\cdot B)(A\cdot B)-(A\cdot A)(B\cdot B)] \end{aligned}\right\} \qquad (2)$$

Based on the dichromatic reflection model, the color vector of every pixel of the image of a monochromatic object is a linear combination of c_b and c_i. The color point set corresponding to all the pixels forms a plane in the 3-D color histogram. The extraction of the intrinsic images is the reverse of the process to form an image by an object and an illuminant based on the dichromatic reflection model. After the matte vector c_b and highlight vector c_i are determined, the color vector of each pixel on the fitting plane can be decomposed into these two vector directions to obtain the two intrinsic images of the original picture, i.e., the matte image and highlight image.

II. Experimental Results and Further Work

The experimental apparatus includes: a PUNIX-TMC56R color CCD camera and an IMAG color image-processing workstation equipped with the three true color image-processing plates manufactured by Data Translation Corporation, DT2858, DT2869 and DT2871, and a SUN386i workstation color monitor. The laboratory is light-tight. A projector is used to produce a white light. Different colors are obtained by using filters. A standard white plate (light source A at 10° viewing angle has chromaticity x = 0.4525, y = 0.4074) provided by the Optical Laboratory of the Chinese Institute of Metrology was used to measure the chromatic coordinates of white light and other colors.

One experimental result is presented here: a deep red plastic cup under yellow light (see Figures 2(a), 2(b) and 2(c) in color inserts No. 13-15 [not reproduced]). It is apparent that the extraction of intrinsic images has successfully separated the invariant color of the object and that of the illuminant and eliminated or reduced the effect of highlight. However, it could not remove or alleviate the effect of shadow. This might be because the incident light was too weak and the performance of the camera was affected. When the incident light intensity exceeds the dynamic range of the camera, the algorithm treats clipped pixels as noise and forms black and white spots on the intrinsic images. These spots can be eliminated by a color smoothing scheme. Presently, the algorithm extracts

intrinsic images of manually segmented pictures of monochromatic objects. The next step is to perform automatic segmentation (rough segmentation) of an image with several monochromatic objects. This can be achieved by analyzing the color point set in the 3-D color histogram and then extract the intrinsic images. The next step is to extract intrinsic images of polychromatic objects.

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A Free Electron Laser With Electromagnetic Pumping Wave

40100020A Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 13 No 6, Nov 91 pp 603-610

[English abstract of article by Yin Yuanzhao of the Institute of Electronics, CAS, Beijing; MS received 4 Oct 90, revised 25 Feb 91]

[Text] A free electron laser with electromagnetic pumping wave is studied. A drifting and rotating electron ring with large radius comes from a magnetic cusp, goes through a cylindrical waveguide and interacts with TE_{11} modes of the waveguide. By making use of the Vlasov distribution theory and the three-dimensional wave equation of waveguide modes, the dispersion relation of scattered waves in Compton region is deduced. According to the numerical analysis, the growth rate and frequency of scattered waves as a function of guide magnetic field, electron beam energy, electron cyclotron ratio and radial position of electron ring are discussed.

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Shanghai's First VLSI Production Line Operational

92P60144B Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 13 Jan 92 p 1

[Article by Ying Yan'an [2019 1693 1344]: "Shanghai's Microelectronics Industry Begins To Take Shape"]

[Summary] Shanghai's microelectronics industry is beginning to take shape, with the municipality's first VLSI production line already in operation. In 1991, the municipality's total output of ICs reached 15.15 million, while total sales reached 16 million, each of these values representing growth rates of almost 50 percent compared to those for 1990. Of particular prominence are nine varieties of LSI application-specific ICs (ASICs) developed in less than a year's time by Shanghai Beiling [i.e., Bell Mountain] Microelectronics Mfg. Ltd. for its S1240 stored-program-controlled (SPC) telephone switch [see JPRS-CST-91-024, 23 Dec 91 pp 23-24]. It is understood from reliable authorities that by 1995, Shanghai will have three major IC production facilities—Shanghai Beiling, Shanghai Philips Semiconductor Co., and the Semiconductor Devices Group—which will have an annual IC output 800-1,000 percent greater than that for 1991.

Early Eighth 5-Year Plan Achievements in Piezoelectric, Acousto-Optic Technologies

92P60144A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 10 Jan 92 p 3

[Article by Luo Junchang [5012 0193 2490]: "Eighth 5-Year Plan's First-Year Results in Areas of Piezoelectric, Acousto-Optic Technologies"]

[Summary] On 11-12 December 1991, the CHINATRON Corp. conducted a formal technical appraisal of 11 scientific research results achieved by MMEI's Institute 26. During this mass certification meeting, 10 of the achievements were judged to be unique or in the lead domestically; of these, six were judged to meet 1980's international standards for products of like kind.

Institute 26, which is the domestic research institute specializing in piezoelectric and acousto-optic technologies, has significantly upgraded its management and quality control in the first year of the Eighth 5-Year Plan, with noticeable benefits. Newly certified devices developed by the institute include a phase-coded surface acoustic wave (SAW) 255-bit tapped delay line with spread-spectrum signal modulation, demodulation, and synchronization functions and several attractive features such as high coding rate, small size, and high resistance to radiation. The certification experts commented that the development of this device represents a major step forward in domestic research on high-bit high-frequency SAW delay lines.

Integrating several disciplines such as dynamics, microelectronics, precision micromachining, micro-thin-film technology, and optics, the institute has also completed initial research on a hemispherical resonator gyroscope, a device critical to the development of angular rate and angular displacement measurement instruments for a strapdown inertial navigation system.

New Digital Display ASIC Developed

92P60144C Shanghai WEN HUI BAO in Chinese 30 Jan 92 p 3

[Article by Qian Weihua [6929 4850 5478]: "Digital Display Micrometer IC Certified"]

[Summary] Shanghai's microelectronics industry has taken a major step forward with the appearance of the nation's first independently designed and developed micrometer (i.e., caliper-type) digital display application-specific integrated circuit (ASIC). This high-tech device passed the technical appraisal held two days ago by a panel of experts from 14 Shanghai research and production facilities. Previously, only Switzerland and Japan have been able to manufacture this technically complex device. Three Shanghai units—Zhuangming ["Brighton"] Information Technology Ltd., Shanghai Semiconductor Devices Institute, and Shanghai Beiling Microelectronics Mfg. Ltd.—jointly developed this ASIC, which meets mid-to-late-eighties international standards, over a two-year period.

Experimental Investigation of Huang X-Ray Diffuse Scattering

40100023A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 13 No 2, Feb 92 pp 75-83

[English abstract of article by Jiang Sinan of the Institute of Semiconductors, CAS; MS received 3 Apr 91]

[Text] The experimental method of Huang X-ray diffuse scattering has been described and has been used to study point defects created by ion implantation of GaAs wafers. Mo and Er ion implantations were made at different regions of one GaAs wafer with the same condition (500 keV, 1 x 10^{15} cm^{-2}). It was observed that the different ions implanted on GaAs wafer exhibited quite different Huang diffuse scattering close to (400) face diffraction Bragg peak of GaAs. Huang diffuse scattering of Er-GaAs was larger than that of Mo-GaAs. This fact may result from the fact that Er is an interstitial atom and Mo is a substituting atom in the GaAs lattice.

X-Ray Double-Crystal Diffraction Study of Si^+-Implanted GaAs

40100023B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 13 No 2, Feb 92 pp 95-102

[English abstract of article by Zhu Nanchang, Chen Jingyi, et al. of the Shanghai Institute of Metallurgy, CAS, Shanghai, 200050, China; MS received 19 Jan 91]

[Text] The 180 keV Si^+-implanted and annealed GaAs(100) wafers are investigated by X-ray double-crystal diffraction (DCD), accompanied by measuring the electrical properties and simulating the double-crystal rocking curves (RCs). The results show that the implanted Si atoms

with the c-axis normal to the film surface. The full width at half maximum of the rocking curve of (005) peak $\Delta\psi$ = 0.4-0.5°. These films had zero resistance transition temperature T_{co} of 84-85K, transition width ΔT_c of 1.5-2K. Films prepared under T_s = 670°C were either epitaxially grown with pure c-axis or grown with mainly c-axis and some (110) and a-axis normal to the film surface. These films had $\Delta\psi$ of 0.6-0.9°, T_{co} of 89-91K and ΔT_c of 0.6-1K.

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Epitaxial Growth of YBCO Superconducting Thin Films by dc Magnetron Sputtering Using a Partially Melted Sintered Target

40100022B Beijing DIWEN WULI XUEBAO [CHINESE JOURNAL OF LOW TEMPERATURE PHYSICS] in Chinese Vol 14 No 1, Jan 92 pp 31-35

[English abstract of article by Ren Congxin, Chen Guoliang, et al. of the Ion Beam Laboratory, Shanghai Institute of Metallurgy, CAS, Shanghai, 200050; MS received 30 Apr 91]

[Text] In-situ epitaxially grown $YBa_2Cu_3O_y$ thin films on (100) $SrTiO_3$ substrates with high critical current density J_c (3.4 x 10^6 A/cm^2, at 77K) and low microwave surface resistance R_s ($\leq$ 37 mΩ, 77K, at 50.9 GHz) were fabricated by dc magnetron sputtering using a large partially melted sintered planar target. A comparable large homogeneous composition region can be obtained. The X-ray diffraction, X-ray double-crystal diffraction and high-resolution transmission electron microscopy analyses show that our deposited YBCO thin films are single crystalline containing mosaic blocks.

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Critical Current Density J_c of Ag-Sheathed Composite Tape of Bi-System Superconductor

40100022C Beijing DIWEN WULI XUEBAO [CHINESE JOURNAL OF LOW TEMPERATURE PHYSICS] in Chinese Vol 14 No 1, Jan 92 pp 60-62

[English abstract of article by Xi Zhengping, Zhou Lian, et al. of the Northwest Institute for Non-Ferrous Metal Research, P.O. Box 71, Baoji, Shanxi, 721014; Northeast University of Technology, Shenyang, 110006; MS received 28 Apr 91]

[Text] The critical current density J_c of Ag-sheathed composite tape of Bi-system superconductor prepared by a three-step reaction process was studied. It is found that J_c values of this composite tape are superior to those of the composite tape prepared by a "blended mixture method." The optimum J_c value is over 1.3×10^4 A/cm^2 (77K, 0T) at an appropriate heat treatment and processing condition.

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Large Satcom Earth Station N:1 High-Power Amplifier System Certified

92P60150A Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 1, Jan 92 p 46

[Untitled article by Yan Xin [0917 0207]]

[Summary] The large satellite communications (satcom) earth-station N:1 high power amplifier (HPA) system developed by MPT's Research Institute 1 passed MPT-level technical appraisal in October 1991. At present, domestic satcom earth stations generally use the 1:1 HPA reserve mode. In the mid-eighties, foreign nations developed N:1 HPA systems with automatic switching designed to accommodate a variety of information types, including non-voice services as well as the traditional TV and telephone. Some domestic satcom earth stations have imported these N:1 HPA systems to meet the nation's needs, but the system developed by Institute 1 represents a significant savings, since it meets mid-eighties international standards at a price only 60 percent that of the imported equipment.

Large Long-Range Radio Navigation System Completed

92P60150B Beijing RENMIN RIBAO in Chinese 10 Feb 92 p 1

[Article by Han Hong [7281 1347]: "Large Long-Range Radio Navigation System Completed"]

[Summary] Xian, 9 Feb (XINHUA)—The nation's first independently designed and constructed large long-range radio navigation system—the "Changhe II" South China Sea station group—has been completed after a 20-year-plus effort by engineers of the Xian Navigation Technology Institute. So far, China is the only nation except for the United States capable of independently producing complete sets of internationally advanced long-range navigation equipment. The appearance of this equipment increases marine navigation range from 500 nautical miles to over 1,000 nautical miles and over 2,000 nautical miles in the ground-wave and sky-wave modes, respectively. The newly developed high-positioning-accuracy system can be used for marine, air, and ground navigation in a variety of civilian and military areas. Total area of coverage in the South China Sea region is over 3 million square km. The eastern sea and northern sea station groups are now under construction, and should be completed in the first part of the current decade.

Large Communications Network for Space Experiments Completed

92P60150C Shanghai WEN HUI BAO in Chinese 15 Feb 92 p 1

[Article by Xu Zhimin [6079 1807 2404]: "Nation Completes Large Communications Network for Space Experiments"]

[Summary] Beijing, 14 Feb (XINHUA)—After a 30-year joint effort between national defense scientists and engineers and PLA personnel, a state-of-the-art large communications network for space experiments has been preliminarily completed, and will be used to guarantee communications for next month's scheduled launch of an Aussat communications satellite. An official from the National Defense Science, Technology and Industry Commission (NDSTIC) revealed to this writer that this land/sea/air high-capacity stereo communications network, which covers all 23 provinces, autonomous regions, and municipalities, includes almost 100,000 sets of advanced communications equipment, and several hundred dedicated stations, as well as the Yuanwang ocean-going space tracking ships. The network, built around digital SPC switching centers and satcom channels, can handle a variety of services, including voice, data, and images, for operators at fixed and mobile stations. At ranges up to 10,000 km, timing accuracy has reached the 1-microsecond level, and transmission BER does not exceed 10^{-5}.

Research at Heavy-Ion Reactor Facility Now at International Advanced Level

92FE0222A Lanzhou LANZHOU KEJI QINGBAO [LANZHOU S&T INFORMATION] in Chinese Vol 20 No 5, 15 Oct 91 p 18

[Unattributed article: "Research at Heavy-Ion Reactor Facility Now at International Advanced Level"]

[Text] The study of heavy-ion reaction mechanisms, a key scientific research program at the Institute of Modern Physics of the Chinese Academy of Sciences (CAS) in the Seventh 5-Year Plan, has been completed after over 4 years of effort by a team of more than 50 technical people. A total of 180 papers have been published and a number of important results have been obtained. Some of the results are at international advanced level. This puts China among the leaders in the world in the study of heavy-ion nuclear reactions. Recently, the project was favorably reviewed by experts organized by the CAS in Beijing.

Study of the heavy-ion nuclear reaction mechanism is one of the major areas of research in heavy-ion physics. It can enrich and deepen our understanding of the characteristics and patterns of nuclear matter.

This major program includes three subjects: "heavy-ion fringe collisions," "heavy ion center-to-center collisions," and "preliminary study of moderate-energy heavy ions." The focus of the study is the transition from low energy to moderate energy. Furthermore, the moderate energy zone is also investigated.

Experts believe that the study confirms the presence of a new mechanism, "non-completely-deep and non-elastic collisions," in light reaction systems. For the first time, complete measurements were made following the progress of fission reactions. Experimentally, two mechanisms, follow-on fission and non-complete-melt fission, were distinguished. Some new phenomena have been discovered and explanations presented correspondingly. Nuclear chemistry methods were used to measure the target fragment mass distribution and linear momentum transfer. For the first time, it was experimentally verified that the linear momentum transfer in a center-to-center collision increases with target mass. Such findings place us at an international advanced level.

These accomplishments have a significant impact on the nuclear physics community in the world and have attracted the interest and attention of many researchers in other countries. A number of world-renowned scientists are seeking for collaborative projects.

Our emphasis on combining theory and practice, strengthening international exchange and cooperation, training and educating young technical talent in the effort, and stressing good management ensured us of this great success.

The Institute of Modern Physics had an early start in heavy-ion physics in China. It has a number of high-caliber, experienced and disciplined experimental nuclear physicists. China's only moderate-energy heavy-ion accelerator is also located inside the institute. Five of the 11 experimental projects were completed on the Lanzhou Heavy-Ion Reactor Facility. The completion of this Seventh 5-Year Plan program demonstrates our strength to compete with the rest of the world. It is a giant step for us to take the lead in heavy-ion physics.

Measurement of Fission Yields From ^{235}U Fission Induced by 24.4 keV Neutrons

92FE0222B Beijing HE HUAXUE YU FANGSHE HUAXUE [JOURNAL OF NUCLEAR AND RADIOCHEMISTRY] in Chinese Vol 13 No 4, Nov 91 pp 237-240

[Article by Wang Dongmei [3769 0392 2734], Zhang Chunhua [1728 2504 5478], Tang Peijia [0781 1014 1367], Liu Daming [0491 1129 7686], Guo Jingru [6753 2529 0320], and Wang Fangding [3769 2455 1353] of China Institute of Atomic Energy, PO Box 275, Beijing: "Measurement of Fission Yields From ^{235}U Fission Induced by 24.4 keV Neutrons"; MS received 11 Jul 89, revised 20 Nov 89]

[Text] Key Words: filtered neutron beam, polycarbonate, fission yield.

I. Introduction

Thermal neutron fission of ^{235}U has been studied in detail. The fission products have been widely measured and the experimental data has been repeatedly reviewed. However, not enough study has been done on mono-energetic neutron-induced ^{235}U fission, especially neutrons in the keV range. J. G. Cuninghame[1] measured the yield of some nuclides in ^{235}U fission induced by 130-1,700 keV neutrons. However, material on fission induced by neutrons below 130 keV is not available in the literature. It is of considerable significance to investigate this area in order to study fission yield as a function of neutron energy.

To this end, we induced ^{235}U fission with 24.4 keV neutrons generated by an iron filter. The fission yields of ^{99}Mo, ^{132}Te and ^{140}Ba were measured radiochemically. The fission number was determined by using polycarbonate film immersed in a standard uranium target solution to record the fission track.

II. Experimental

1. Preparation of Uranium Target

Take approximately 0.5 g of uranium shaving (90.1 percent ^{235}U) and boil it in 2 mol/l HNO_3 to remove the oxide layer. Weigh it accurately and seal it in a 4-mm-diameter, 25-mm-long polyethylene tube to serve as the specimen target.

Place a 50-μm-thick, 3 x 20 mm polycarbonate film into a 4-mm-diameter, 25-mm-long polyethylene tube which is sealed in one end. Fill it with a 137.5 mg/ml $UO_2(NO_3)_2$ solution (identical in ^{235}U abundance to that of the specimen target). After heat sealing the other end, it serves as the standard target.

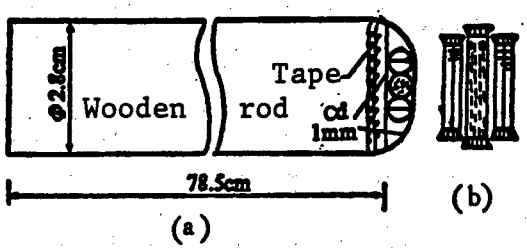

Figure 1. Layout of 24.4 keV Neutron Irradiation—(a) Overall layout, (b) Target arrangement

2. 24.4 keV Neutron Source and Irradiation Layout

The 24.4 keV mono-energetic neutrons are produced by passing neutrons from horizontal channel 5 of the swimming-pool reactor at the China Institute of Atomic Energy through a Fe-Al-S filter. The neutron injection rate is approximately 3 x 10^5 n/cm^2-s.

Take a 2.8-cm-diameter, 80-cm-long wooden rod, and at one end of the rod attach a 1-mm-thick sheet of cadmium. Sandwich a specimen target between two standard targets and place them on the cadmium sheet and secure them with tape. After reactor power is stabilized at approximately 3,600 kW, very quickly insert the rod all the way into the filter channel tightly against the filter. Take it out after a fixed time of exposure. The sample goes in and out in less than 10 seconds. The entire irradiation layout is shown in Figure 1.

3. Measurement of Fission Number

The polycarbonate film is removed from the standard target after irradiation. After decontamination and etching, the fission track is read under a microscope. The detailed procedure is available in reference 3. The fission number in the specimen target is calculated based on the mass of the uranium in the specimen target and on the efficiency factor of the fission track recorded on the polycarbonate film.

4. Measurement of Fission Products

Shear open the specimen target half an hour after exposure. The uranium shaving is poured into a flask filled with HNO_3, HCl and carrier solutions for Mo, Ba and Te. The solution is slightly boiled for 30 minutes to allow the ion exchange process to finish. Mo, Ba and Te are systematically separated. A standard radiochemical analysis method is used for purification, source preparation and determination of chemical yield.[4] The separated samples are analyzed with a low background 2π gas-flow proportional counter and a 2π scintillation counter to determine their β radioactivities. The efficiencies of the counters have been carefully calibrated.[5]

5. Computation of Fission Yield

Fission yield, Y_f, is calculated as follows:

K_{wet} is the efficiency factor (cm) of the polycarbonate film

$$Y_f = \frac{K_{wet} A_0 C t}{Y_c \varepsilon W T_d (1 - e^{-\lambda t})} \qquad (1)$$

used to record the fission track with a calibrated scale of 8.52 x 10^{-4} cm,[3] A_o is the radioactivity count when the measurement source stops irradiating during radiochemical analysis of a certain nuclide (min^{-1}), ε is the detection efficiency for measuring the radioactivity of a nuclide, Y_c is the chemical yield, t is the irradiation interval (min), C is the uranium concentration in the standard target (g/cm^3), W is the mass of uranium in the specimen target (g), T_d is the density of fission track (cm^{-2}) and λ is the decay constant (min^{-1}).

III. Results and Discussion

In order to verify the homogeneity of neutron injection rate, three plastic tubes with a piece of polycarbonate film each were filled with 10.15 mg/ml uranium solution. They were arranged in such a way as to simulate the arrangement of the specimen and standard targets and were irradiated for 4,280 minutes. The fission track densities on the three films are 7,911, 7,813 and 8,082/cm^2, respectively. The mean is 7,935 +/- 136/cm^2, which illustrates that the neutron injection rate is essentially identical. The inhomogeneity is less than 1.8 percent. This means that the fission number of the specimen target can be obtained from the two polycarbonate films immersed in the standard targets.

We irradiated six uranium targets and measured the fission yields of ^{99}Mo, ^{132}Te and ^{140}Ba. These nuclides are important fission products which are located near the peak of the mass distribution curve. They are often used as standard nuclides for measuring fission yield and fuel consumption. The results are shown in Table 1. The total uncertainty of these yields is estimated to be 4 to 5 percent.

Table 1. Fission Yields of ^{99}Mo, ^{132}Te and ^{140}Ba

Target number	Uranium target mass, g	Irradiation time, min	Track density, cm^{-2}	Fission yield, %		
				^{99}Mo	^{132}Te	^{140}Ba
1	0.2982	1450.0	6.321×10^4	4.78	3.29	
2	0.4958	2429.0	1.068×10^4	4.45		
3	0.4906	1879.0	8.155×10^4	4.49	3.02	
4	0.5011	1481.0	5.938×10^4	4.63		7.60
5	0.5034	2528.0	6.585×10^4	4.76		7.96
6	0.4499	2532.0	6.835×10^4	4.67		7.99
Average				4.63	3.16	7.85

Using 24.4 keV filtered neutrons to study fission yield has never been reported in the literature. Because the data was obtained for the first time, we could only compare with yield data obtained with comparable neutron energy. J. G. Cuninghame[1] measured the yield of five nuclides, including ^{99}Mo, and ^{140}Ba, in ^{235}U fission induced by 130-1,700 keV neutrons. In Table 2, the yields obtained at the lowest point, i.e., 130 keV, and the yields obtained with thermal neutrons (0.025 keV) are listed for comparison with those obtained in this work at 24.4 keV.

Table 2. Comparison of Fission Yield Data

Nuclide	Fission yield at different neutron energy, %		
	Thermal neutron[6]	This work, 24.4 keV	130 keV[1]
^{99}Mo	6.114	4.63	5.70
^{132}Te	4.285	3.16	
^{140}Ba	6.296	7.85	6.10

From Table 2 we can see that the yields of these three nuclides are fairly complicated. They are located at the peak of the mass distribution curve. In general, the yield of nuclides near the peak falls with increasing neutron energy. The yield for ^{132}Te at 24.4 keV is smaller than that for thermal neutrons, which is consistent with this pattern. The yield for ^{99}Mo at 24.4 keV is less than that for thermal neutrons and is also smaller than that at 130 keV. ^{140}Ba has a higher yield with 24.4 keV neutrons as compared to thermal neutrons.

The thermal neutron yields listed in the table are edited values, with an uncertainty of less than 1 percent. The uncertainty of this work is 4 to 5 percent. The yields obtained with 130 keV neutrons have an uncertainty of approximately 7 percent. Hence, we believe these anomalous effects cannot be explained with error. In order to clarify these questions, we must make more yield measurements for comparison in order to find a pattern. However, the low injection rate of 24.4 keV neutrons makes it more difficult to measure more nuclide yields.

In spite of this fact, the yield data collected for 24.4 keV neutrons is still of great significance to the study of nuclide yield as a function of neutron energy with mono-energetic neutrons.

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